TO THE
BUILDERS
OF TOMORROW

TO THE BUILDERS OF TOMORROW

BY

MADHURI DESAI

FOREWORD BY

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GEOFFREY CUMBERLEGE
OXFORD UNIVERSITY PRESS

Oxford University Press, Amen House, London E C 4

EDINBURGH GLASGOW NEW YORK TORONTO MELBOURNE
WELLINGTON BOMBAY CALCUTTA MADRAS CAPE TOWN

Geoffrey Cumberlege Publisher to the University

First published 1948

Printed in India by B G Dhawale, at Karnatak Printing Press 103, Sion (East), Bombay 22 and published by Geoffrey Cumberlege, Oxford University Press, Bombay

He was of the soil, brought up in the sticky mud of the Indian village. Fearlessly he broke away from the old retrograde society that sought to engulf him. He was born in an age when diseased man was at the mercy of merciless fate. He lived to see the triumphant march of science, and the force it radiated in the conquest of the bitterest enemy of mankind—disease.

He had faith in constructive science. He hoped that the builders of tomorrow would step forward, and succeed in admitting light into the dark, filthy, stinking hovels of our villages and towns.

TO BHAI

Born of the people, hewed by the people, he lived and died for the people.

'I look for you everywhere, and find you not.'

FOREWORD

IT HAS been a rare pleasure to me to read through the manuscript of *To the Builders of Tomorrow*. I have had the privilege of knowing the author for many years. However I must confess that I had never suspected that behind that modest and charming personality was hidden a writer of rare merit who, as a lay person, has succeeded remarkably in presenting an account of the evolution of modern medicine in a readable and interesting manner.

It is a sad commentary on the Indian medical practitioner that it should be left to a lay person to write this book. But then Medicine has always learnt from the priest, the barber, the postman, the street vendor and others. It is with the full knowledge of the guilt that lies on the head of the medical practitioner that I have consented to write the Foreword.

This book deals with the Romance of Medicine and brings home to the reader the long way that Medicine has travelled from the marshes of magic and mysticism to the bright and promising fields of scientific and rational practice.

The modern child, as the result of the prevailing system of education, grows up to believe that modern civilization is the direct outcome of the attainments of victorious warriors and successful politicians. There is no room in the curriculum of studies of the youth of this country for him to know the work of those who toil and sweat behind the test-tubes and the microscopes, and who submit themselves to dangerous experiments so that disease may be conquered and man may live healthily and happily.

However glorious may have been the civilization of the past, it is certain that none of them could claim cities of the magnitude of New York, London, Berlin, Moscow or Bombay. In those 'good old days' a city could not grow beyond a certain size because of a fearful mortality resulting from unhygienic ways of living. It is Medicine that has made it possible for the architects and the engineers to build their modern mammoth cities. Soviet Russia seems to be the only state where the pride of place in society is given to the scientist, and where Medicine seems to be the centre round which every new enterprise is built. This has been well brought out in the concluding chapter of this book.

Science will play an important part in the world of tomorrow. Builders of tomorrow will find in this book a message which will make them realize that healthy living is an essential requisite of human progress. The beautiful illustrations enhance the value of this book. The message contained in the book should be made to reach the whole length and breadth of this country. It is devoutly to be wished that translations of this book will appear in the different provincial languages of this country.

Builders of tomorrow, keep the torch of Medicine in the forefront of your progress. It has guided you from the dark ages to the present enlightened period. It will guide you to a full realization of the rarest gift of God—Life.

21 Queen's Road, Bombay
11 January 1947

PREFACE

I TAKE this opportunity of acknowledging my debt of gratitude to my friends for the kindness, sympathy and sustained interest they have shown during my first venture into the realms of book-writing. They have appreciated my motive-spring in writing the book: an attempt to bring much needed knowledge to the generation of the builders of tomorrow, so that the days of filth and frustration may end.

I must make special mention of the great trouble taken by my friend, Dr R. N. Cooper, who read the whole manuscript and checked up the medical facts. He very kindly put at my disposal his library and helped me to wade through the technical aspect of medical science. Mr Jamshed J. Bhabha, another friend, offered valuable suggestions after reading through the early part of the manuscript.

Mr W.E. Nenninger furnished me with medical literature and much useful material was gleaned that way.

I am obliged to Mr Mithaiwalla and Mr Ananda Tamhane who supplied the photographs for Plates 1(a) and 1(b).

Last but not the least, I must acknowledge the unstinted labour of a friend who insists on remaining nameless. He relieved me of the burden of looking after the book in the press, helped me to gather the illustrations and spent a lot of his valuable time in seeing that this my first effort did not lack the best that technical aid could procure in this country.

To you all, I am deeply grateful.

M.D.

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LETTER I

THE ORPHAN'S WAIL

LINA AND VIJAY,

I am beginning a series of letters which I want you to read carefully. They will tell you about a world which does not form part of your school curriculum. And yet it is essential knowledge, if you are to grow up to be useful citizens. I shall write nothing which will be technical, and I shall avoid all big words as far as possible.

Let me tell you how the idea of these letters originated. It was a sunny day in the month of December. The weather was bracing. I set out for a long walk in one of the distant suburbs of Bombay. Perhaps you have been to Ghodbunder, and you know what an attractive place it is. I left the main road, and followed a pathway that brought me to a secluded hamlet. There, under a big neem tree, I saw a young lad about twelve years old, who seemed to be resting. I approached him, and to my surprise found him awake and weeping profusely. His grief aroused my sympathy. I went nearer him, and asked him his name. With difficulty he controlled his sobs, and told me his story.

'Rahoul is my name. I am the only son of Balraj. My father was a farmer. The field you see in front of you was tilled by him. We are poor folk, and my father used to work very hard. Today he is no more. I am left alone—utterly alone. I have become an orphan.' He broke out into sobs again; 'Pitaji! Pitaji!' came in heart-rending cries from the grief-stricken Rahoul.

He told me the pathetic story of his father's death, which had occurred only three days earlier. He described to me his struggle not to allow the body to be burnt. He had been forced not only to accompany the bier to the cremation-ground, but had also been made to light the funeral pyre.

'Yes, all father's friends had gathered at the burning ghat, and one of them clutched me from behind, and made me put the burning torch on father's face. How could they do it? They are cruel men—Is it not possible for the dead to live again? The pujari in the temple, when he recited the *Mahabharata,* talked about Satyavan being brought back from the clutches of death by Savitri. Could not the doctor have been mistaken when he said Pitaji was dead ? I can say father was only asleep. It was deep sleep. He was certainly not dead ', he pleaded with me.

I asked him what had ailed his father. To this he could give no clear answer. He said: 'Father had become very pale and weak during the last few months. His hands were always cold. He would get fits of shivering. They said the devil entered his body. His teeth would chatter and he would feel the cold entering his very bones. All the coverlets in our house would be piled on him, and yet he would ask me to sit and rub his body to make him warm. When I rubbed very hard, the devil would run away, but father would become very hot—burning hot. He would tell me: "The fever is burning me inside," and ask me to prepare hot tea. Every alternate day he would get this fever. When the fever left him, he became very feeble. This last time when he got the fever, he talked in his sleep. I could not understand him. The neighbours told me to call a doctor. Before I could get the doctor to come, they told me that he was dead. When I rushed up to him and touched his hands, I found them icy cold. I touched his feet, and they were also cold. I called to him and tried to awaken him by kissing his face. He always woke up when I did that. But this time he took no notice of me. His eyes were shut, and he would not open them. Then the old woman next door entered the room and dragged me away. They said he was dead— I had heard of people dying in the village, but I had never seen a dead person— I do not remember my mother's death. I was very young then— They said father was dead!'

'You must go home, Rahoul,' I told him.

'Home! Home! The home feels empty. It is so lonely there. It is much better here, so that the old woman next door does not nag me. It is true father used to be away at the field all day long. But somehow the thought that he would come home in the evening was enough to make me feel that he was there. Now they have burnt him, and everything feels empty.'

Rahoul was not to be comforted. He had developed a grudge against life itself. 'My father was a good man. He never beat me. There are fathers who are drunkards, and who beat their children. Why should my father have been taken away from me? Why could he not be saved? Is there no medicine to cure sick people?' And he burst into tears again.

I spoke gently to Rahoul and assured him of my interest in him. I explained to him that there was medicine to aid and cure the sick. Man had made great progress; he had waged a heroic struggle and succeeded in conquering and wiping out many diseases. Rural India

was backward, and many people died because of lack of medical aid. His father was an unfortunate victim of poverty and neglect.

Rahoul was interested. Gradually he forgot his tears; he came to me day after day, and listened to my words with rapt attention. For his sake I ransacked libraries and visited doctors to find out about the discoveries that have helped mankind to be safe and healthy and to fight against disease. I myself became interested in the gathering of this knowledge. I propose to put down in these letters all that I found, so that you may know how science has been working to save fathers and mothers, brothers and sisters, from untimely death due to ignorance of the causes of diseases.

Yours affectionately,
MASHI

LETTER II

THEY HELD BACK THE FUTURE

LINA AND VIJAY,

The simple words of Rahoul 'The devil entered his body' make me think. I realize the dark depths of his ignorant mind—full of strange beliefs and ugly superstitions. The words vividly remind me of the subtle power such beliefs exercise even over so-called civilized and educated beings.

I remember Father's recent illness, eventually terminating in his death. The picture of the sick-room flashes before my eyes. Death is merely a question of days. I collapse in my chair and utter fervent prayers, in whatever broken words that occur to my distracted mind, for a miracle to happen. I depart from rationality. Out of sheer desperation, I yield to the instincts of primitive people. I submit to the blandishments of faith-healers and miracle-workers, who offer to exercise their supernatural powers to save the life which is fast ebbing away, and which medical science declares cannot be preserved any longer. I search the almirahs for an old horoscope. I read through the predictions of astrologers. They all agree that death is far away from the days we are facing. One of them presents himself and reassures us: 'He will not die. It is only a passing crisis. Do not grieve. He has already weathered the worst storms, and in three days he will be well again.' I cling to these glibly spoken words, as a drowning person catches at a straw.

I recall the young earnest lad who came to our home twice a day, for eight days in succession—the period of final crisis. He touches Father's feet, chants mantras and gives him holy water to drink. '*I am a devotee of Hanuman*,' *he says. I remember how* relieved I feel when this young enthusiast comes and tells me that his 'benevolent and benign deity' has listened to his prayers and insistent fasts, and has given him *darshan*. The god has even whispered in his ear: 'Rejoice! I am pleased with your penance. Your request is granted.'

We are like demented folk. We are prepared to go to any length to save Father's life. Our credulity acquires amazing dimensions, like the God Hanuman himself, who is reputed in mythology to possess the power of growing weightier than a mountain or lighter than a blade of grass.

Let me recount another episode. A well-meaning friend

approaches me and says: 'I was like you, feeling lost and beaten, when recently my daughter was dying from pneumonia. The doctors had given up all hope. A spiritualist arrived at our house. He asked us to have faith. He did not interfere with the medicines and injections of the doctors. All he wanted was to be allowed to chant some secret mantras he had learnt in the hallowed land of Tibet. He had consecrated relics with him, copper plates and copper wires which were the gifts of ancient saints and sages. These had the magic power of sucking out the poison—the devil —that was tormenting my poor daughter. Why not let this spiritualist try his hand, when science has failed you?'

North American medicine man

I yield once again. I have definitely reached the low-water mark of my faith in science. The priest begins the chanting of the mantras and claims that it has a quietening effect on the patient. Delusion has gone far enough for me not to realize that his deep coma is deepening every moment, and what we take to be peacefulness caused by mantras is a sign of failing life, not of returning life.

And so we lost Father. The object of relating this personal episode of my life is to tell you how we are apt to falter when the fearfulness of primitive man rises in us. Face to face with the fear of losing Father, powerless against the natural forces that were dragging his body down to death and dissolution, we turned to the hidden hand of supernatural mystery for aid.

The origin and history of primitive beliefs and superstitions have been unravelled by clever men. These beliefs have been formidable obstacles in the path of progress. They have held back the future. They have helped to keep masses of people in subjection because they have encouraged ignorance about the laws of nature and preached blind submission to the powers that rule society.

I want you to listen to one of these clever men, an anthropologist.

He tells us that primitive man believed that disease was the result of forces generated by supernatural agencies. In Africa, the disease of leprosy is said to be caused by the deity Jok, who spits on you when you offend him. Similar examples can be quoted from every continent in the world.

Early Stone Age shaman dressed in deer-skin, for the ritual dance
(*French Pyrenees grotto*)

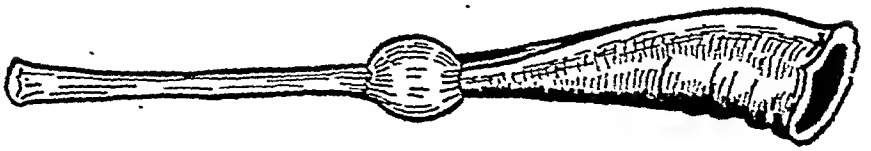
Disease is always accompanied by pain. Our ancient ancestors turned to the crafty medicine-man, the shaman, for relief from pain and pestilence. The shaman was a keen observer, and knew the rudiments of human nature. Usually he had no remedy for the cure of a particular disease, so he cleverly fell back on what is called Mumbo-Jumbo. He dressed in strange clothes, utilizing the skins and horns and feathers of animals and birds from the forest. Grotesque masks were a later edition of this uniform borrowed from ferocious and untameable creatures.

Now the shaman was ready to hold court in the smoke-filled crowded hut. First he talked with the deity to find out if prayer was useful. After that came rhythmic beating of the drum and unintelligible chants, interspersed with piercing yells, wild dances, bodily contortions, banging of rattles and flourishes of sticks. This wild display was meant to distract the mind of the patient from his pain.

Assyro-Babylonian demon
(*Bronze*)

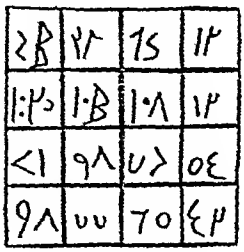
The shaman was clever with his hands. Though naked except for a small loin-cloth, he could produce pebbles, crystals, thorns, bugs, worms, wolf-hair, or even small snakes—revolting objects—with expert quickness of the hand. He made the patient believe that they had been inside the affected part of the body, and that with his grunts and incantations, he had successfully extracted them. This was easy when he made use of sucking, blowing, or cupping during his healing ritual. Wicked witches were declared to be responsible for causing diseases by shooting these

objects inside the patient's body. Cupping always extracted them.



African cupping horn, 5" long

The amulet was an instrument of healing for the medicine-man. He fell into a trance and mumbled words of magic over some stone or cryptic writing on a leaf. With a show of awe-inspiring wisdom, this amulet was tied round the neck or the arm of the patient. 'Never lose it. It will protect you from all evil spirits. Remember, you will incur the wrath of the Mighty Spirits if you throw it away or befoul it.' Faith was created to bring about what seemed like a cure.



Egyptian amulet to ease birth-pains

The art of the shaman was not easily learnt ; it required a long apprenticeship. Jugglery was one of the accomplishments of the shaman. He had to drink poison, see visions, go into trances, perform feats of abstinence. He had to be a first-rate showman, a scholar well-versed in the knowledge of the ways of animals and plants, a link with supernatural powers, and a psychologist who knew his tribe and its taboos.

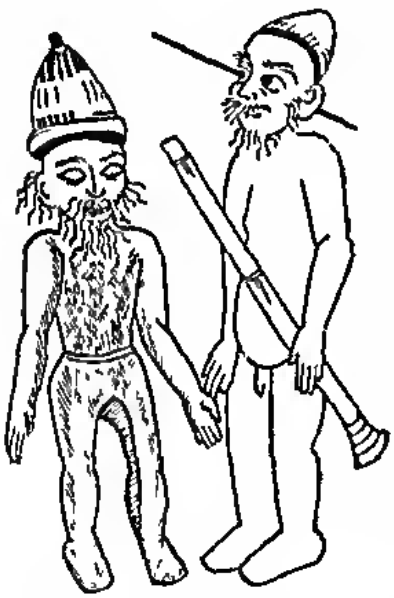
Here is a true story of an old woman-diviner. She healed the sick by applying poultices prepared from cow-dung. As the ritual of preparing the poultice was going on, she cleverly inserted a small dead lizard in the cow-dung. Chanting and yelling, cursing the spirit which was troubling the patient and ordering it to leave the body, sucking the affected part, and finally applying the poultice, she continued the performance with great skill. She then pulled off the poultice with a graceful gesture and dashed it on the ground. The spirit was supposed to have been drawn out, and was seen in the form of the dead lizard in the poultice. The hypnotized crowd acclaimed her as their saviour. She became a power in the tribe.

The difference between the savage and the civilized mind is one of knowledge. Primitive minds easily turned to mystical explanations for what they could not understand in nature. The medicine-man was powerful because he claimed influence upon the unknown

demons and deities who visited the world with floods and earthquakes. He was reputed to be on intimate terms with the Spirits of rain, fertility and crops, and with the devils who brought diseases.

Eskimo shaman exorcizing the devil
(Walrus ivory etching)

The medicine-man built up a whole cult round himself. He said that magic would be used against you if the medicine-man of your enemy got hold of a tuft of your hair, a nail-paring or tooth, your child's navel string, or a piece of your clothes or faecal matter; even the skin of a fruit you have eaten, the bone which had touched your lips, or your footprints in the sand, were a source of danger. If the hostile medicine-man burnt the faeces, his magic gave you dysentery; he burnt your hair, and you burnt with fever; he made your image in clay, and ran a needle through its eye, and you got blind; or if he ran it through the heart you suffered from heart-pangs. The wet earth where you had spat was enough to enable the sorcerer to cast a spell over you and kill you.



The Black Devil of disease (left) and the White Spirit which protects against all evil (right)
(Malayan)

Witchcraft became a part of the medicine-man's stock-in-trade. If he once succeeded in making the effigy of a man, he claimed that he then controlled that man's soul. He had merely to get a lemon, swing it round the head of a sick man seven times, and the devils that were tormenting the body then inhabited the lemon. All that was now necessary in order to send the disease into the body of an enemy was to hit his effigy with the lemon! The sick man was declared cured, and his enemy was henceforth the victim of the devils expelled from his body.

The shaman told his patients that diseases were caused by the entry of spirits into the body of the victim. He explained that the

only way of preventing increasing weakness was to bleed the patient, and allow the blood to ooze out profusely so that the spirits could find an outlet. Having provided the outlet, the shaman helped with his incantations and mumbo-jumbo to force the devil to leave.

We have evidence from China that the medicine-man fell into trances and inflicted wounds on himself as part of his mystical ritual.

Sinhalese devil—Mahakola Yaksha. The smaller heads are of the demon of griping, cold, blindness, fractures, dysentery etc.

A ball with a hundred and eight spikes, each symbolizing an evil spirit, was used. The more the shaman pricked his arms, face, tongue, chest and legs, the more blood flowed, and the surer the recovery. Japanese folk-lore has stories of a giant demon capable of swallowing the whole world, with a myriad satellite demons. Some of them are reserved to represent diseases. The *Shoki* is the benevolent spirit of Japan, which chases away devils. The *Shoki* is seen on festival banners even today in Japan, especially at the May Day Festival, and it is said to drive away plague and other diseases.

There were three well-marked sources of danger for primitive

man: the demons who could destroy him; the malevolent spirits of dead men, dead animals, or even plants; and lastly, human enemies using sorcery and magic. The 'evil eye' had to be averted; disease had to be fought; death staved off. The medicine-man promised to exorcize the demons, pacify the spirits of the dead, and frustrate sorcery and magic. He did a roaring trade in his passionate incantations, secret amulets and charms, along with the fetishes he prescribed. 'You shall not eat this,' or 'You may not do that,' were prescriptions to appease the fickle likes and dislikes of the spirits.

Arabian Unicorn
(*After the 'Discourse by Ambrose Pare', 1582*)

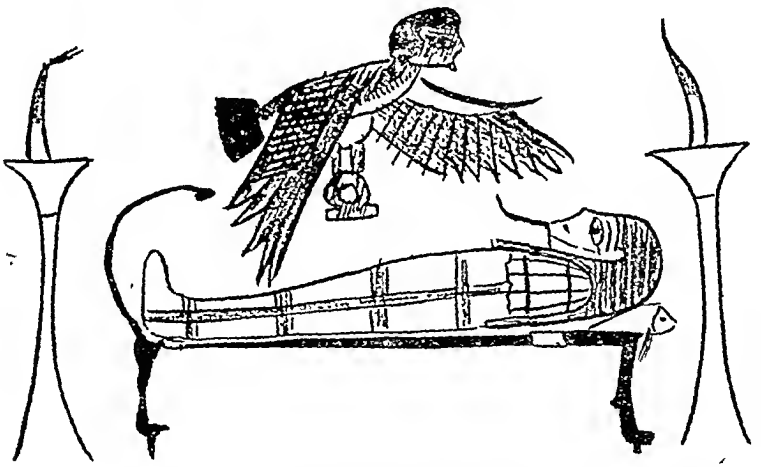
The medicine-man looked about for what he could best use for his mumbo-jumbo. The more uncommon the object, the better its effect. A piece of iron was a rarity in those days, as well as still-precious gems like pearls and rubies. All these were straightaway declared by the medicine-man to possess great protective qualities: the milpreve blue-stone defied serpents; the unicorn's horn gave protection against poison; the toad-stone was also a protection against poison, and gave warning of its approach by becoming very hot; bezoar-stones, secured from the stomach or gall-bladder of animals, healed every kind of malady.

But every medicine-man could not procure rarities all the time, so common-place objects were cloaked in mysterious garments. The waters of wells and springs were transformed into the abodes of benevolent spirits. The saliva secreted in the morning in the shaman's mouth was declared efficacious for wounds, sores and skin rashes. In Ireland, saliva from a fasting medicine-man was mixed with clay from a holy well and used for sore eyes.

Removing the toad-stone

'Loss of soul' was one of the reasons given for a prevalent disease. The older primitive societies always made the soul a substantial part of the human being. As religions of a higher order developed, the soul became a vague and mysterious entity. Professional soul-catching medicine-men were known as *dayong* in Borneo. The *dayong* arrived at the patient's bedside, and felt for his soul. Mostly he found the soul playing truant, and used his occult powers to locate it, sometimes as far away as the abode of the dead ancestors! The ceremony began at night, with torches burning and a ring of spectators placidly squatting down for a long entertainment. The *dayong* went into a deep trance, but not deep enough to cease to demand more and more inducements by way of offerings of grain and gongs and skins, as stimulus for the chase. The assistants interpreted the different contortions of the *dayong* as stages on the journey of the soul, and the obstacles it was surmounting. Ultimately, the *dayong* jerked himself free from the trance and opened his tightly closed fist. Those who cared to see observed a grain of rice or a pebble or an insect inside the palm; the recaptured soul was supposed to be contained in it. The object was rubbed on the patient's head, and the soul forced down into his body.

Assyrian demon
(*Paris Museum*)



Soul hovering over its mummy
(*Egyptian papyrus painting in British Museum*)

The shaman was essentially a man of strong imagination. For a lunatic or a malingerer, he used a thick whip from the skin of a pig or a rhinoceros, whichever animal was easy to get. Severe whipping of the patient was supposed to make the demon howl with pain, and when the victim fell down unconscious, the demon was declared to have left him. The medicine-man was ruthless in his remedies. Scalding for pains in the abdomen was very common. The remnants of scalding-to-heal practices can be found in many parts of our countryside even today.

Aztec medicine man portrayed in aboriginal codex (*Sixteenth century*)

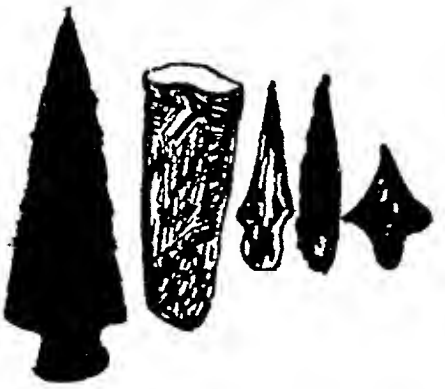
It would however be a mistake to believe that the medicine-man was always a crude faith-healer. In course of time, he developed into a rough-and-ready physician. His remedies were based on what he had seen and experienced—the inexplicable circuit of effect following a particular cause. He found certain herbs and seeds useful for relieving complications in the patient's body. Castor-oil seeds emptied the bowels; *dhatura* leaves relieved inflammation and pain, and *dhatura* seeds brought sleep and holy delirium; mistletoe juice induced sleep; neem leaves or cinchona bark, when boiled in water and drunk hot, drove out the devil, the cause of fever and headache. The medicine-man stumbled on many remedies by observing how animals acted when in bad health. When a dog got sick, it refused to eat its normal food and ate green grass instead, and then got well. The medicine-man made a decoction of green grass for his next bunch of patients. He found that every kind of grass did not give the same result, so the next step in reasoning was not difficult. A particular root or bark or herb was evidently suited to one particular kind of disease. The medicine-man learnt other things by watching wounded animals. Wounded dogs and cats licked their wounds to heal them. A dog which had broken the bone of its leg went about on three legs, keeping the injured leg in such a position that, when the bone healed, there was not much shortening. From the hippopotamus he learnt the process of blood-letting: it would press its leg against the stump of a reed just at the point of a vein and, after

sufficient blood-letting, cover the wound with mud. When blood flowed from a wound, he saw the monkey try to stop the flow with its paw. When a thorn got into its body it removed it carefully with its paw, without breaking it. He observed bears eating arum leaves to cure stomach-ache, stags using leaves of dittany for curing wounds, tortoises wild marjoram as an antidote for snakebite. Medical science was groping its way into existence.

The narrow and blind experimentalist, this empirical doctor, was the real ancestor of our modern physician. By devious path-ways, through exorcism of devils and protection by talismans—has arrived our knowledge of diseases and the scientific basis of their cures. The fierce medicine-man sometimes struck the right chord—accidentally and in spite of his ignorance and superstitious beliefs in devils and demons. The methods of cure which a modern doctor practises may resemble that of the medicine-man of yore, but it is based on knowledge of the causes of diseases, on a scientific system of diagnosis and treatment. The healer today takes his stand on rational ascertained facts and scientific conclusions. He has no use for blind faith in the 'hidden hand' of gods and devils, or spirits good or bad.

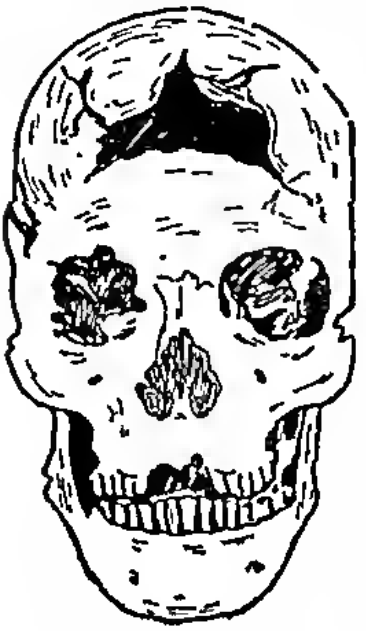
Skull from Peru (*San Diego Museum*)

I shall cite an example of how the medicine-man anticipated the modern brain surgeon. If you ever go to an archæological museum, be on the look-out for skulls of our oldest ancestors. Excavators have found skulls in Peru and other parts of the world which have strange holes in them. The surface of some of the holes show a rounded edge. The bone grew after the wound was made. The owner evidently lived on for a considerable



Trephining instruments from Arkansas

time after the puncture was made with the sharp-edged flint. The medicine-man argued that epileptic fits, severe headaches, and insanity were caused by the devil sitting locked up inside the brain. In order to drive him out, an opening had to be made in the skull.



Trephining by the shaman. Skull from Tepe Hissar

The medicine-man's instruments for his trephining operation were wine to make the patient unconscious, a pointed flint to bore the hole, the glowing flame of fire as the disinfectant, and wet moss as an antiseptic bandage. When the patient's fever rose after an operation, he declared that the demon was a strong one and was putting up a fight; when pus began to flow out of the wound, he explained that the devil was leaving the body. Sometimes the man recovered. If the convulsive fit recurred, another puncture was made, this time on the opposite side of the head.

We have skulls in which there are several holes, each of a different date—some more healed than the others. The medicine-man was a skilful surgeon; but where his empirical wisdom ended, his hocus-pocus began. The demon was made responsible for his ignorance and unscientific failures.

The dust of several thousand years has accumulated on the charred remains of the medicine-man. He may have been a boon for his times, but he is a positive menace to us today. He is physically dead and gone, but he lives amidst us, and often rules over us. Examine your beliefs, scrutinize your unconscious little mannerisms and 'instinctive' *reactions, and you may find the medicine-man hiding in the hair on your* head playing havoc with your mind, or underneath your shirt frightening your heart. We must constantly be on our guard against the medicine-man.

The mountain of civilization man has built may look solid and unshakable. But the spirit of the medicine-man is like the rumble of the earthquake. We cannot see where it will end. Given a chance, the medicine-man can smash up our progress. Beware!

Yours affectionately,
MASIH

LETTER III

LINA AND VIJAY,

I wonder if you have kept the skin of a snake you picked up one morning during your rambles in the pine forests of Kausani. How excited you were!

You had not seen the snake undress. It had taken off its coat, laid it out neatly on the grass, and swiftly slipped away into the undergrowth.

That snake of Kausani has a parallel with social growth in history. Unobtrusively the snake abandoned its old skin, and hurriedly crashed through the thick shrubbery, glorying in its new garb. Similarly, society emerges from its primitive casings, and displays new apparel of fresh eras in history.

When the snake had changed its skin, it had lost neither the mottled design on its back, nor the venom in its mouth. Even so, society retains its blind beliefs in demons, and its unreasoning faith in superstitions regarding the causes and cures of diseases.

Along the long trail of man's march through the thick forests and rocky hills on the steep road to modern civilization, you can collect several coats of discarded beliefs. And yet the poison of superstition is still ingrained within man's head, and his back is burdened with the load of fear and ignorance.

Glance through the pages of medical history, and you will come across glaring hoaxes practised by saints and charlatans on unsuspecting sick humanity. We shall have to wade through 'faith and filth' in the last two thousand years of medical deceptions in the lands of Western civilization.

At the very inception of the Christian Era, legend declares that Jesus Christ set the standard in curing by miracles. He took upon himself the burden of 'sins' of the sick and the ailing, and put his seal of approval on healing-by-touch.

In the fifth century, St Augustine stoutly declared: 'All diseases of Christians are to be ascribed to demons; chiefly do they torment the fresh baptized, yea, even the guiltless new-born infant.'

A century later, Gregory the Great, reputed for his enlightened catholicity and wide knowledge, solemnly related the story of a nun who swallowed a demon. She ate a lettuce without making the preliminary sign of the cross. The demon was sitting on the lettuce, of course invisible to the nun. Once inside her stomach, the demon began to

pinch her. She shrieked for aid. The good and great exorcist came to help her and began to drive the demon out of her. The demon resisted and pinched her more and more. When he was finally ousted, he shouted through her mouth: 'Why am I to blame? I was sitting on the lettuce, and this woman, not having made the sign of the cross, ate me with the lettuce!'

A medieval saint exorcizing the devil (*Old woodcut*)

If this story were true, how many demons you and I have swallowed! But evidently the demons only pinched ascetic Christians in the sixth century.

The victims of disease were branded as heretics—persons whose faith was supposed to have weakened in God and his Church, or who had sinned grievously and offended the all-merciful Creator. The priests interceded on behalf of the ailing by prayers, touching the cross and other holy relics to exorcize the devil. Often during epidemics, when disease still persisted, in spite of the intercession, patients were tied together and brought to church to be cured. They were left on the floor without food or water. Most of them died.

In those dark ages of medical history, holy relics assumed a role of great importance. Whatever the disease, however it might have been contracted, a miraculous cure was guaranteed if a piece of wood from the original cross on which Jesus Christ was nailed, touched the patient. Soon a lively trade in holy relics arose.

I shall cite some glaring instances of such frauds practised on trusting humanity. The return of the Crusaders and the annual pilgrimages to Jerusalem—the Land of the Lord—furnished the fairs and Church celebrations all over Europe with prized relics century after century. Chips from the Cross of Jesus were available for a fabulous price, irrespective of the fact that if all these chips were put together in one place, they were sufficient to build several houses, and not merely one cross.

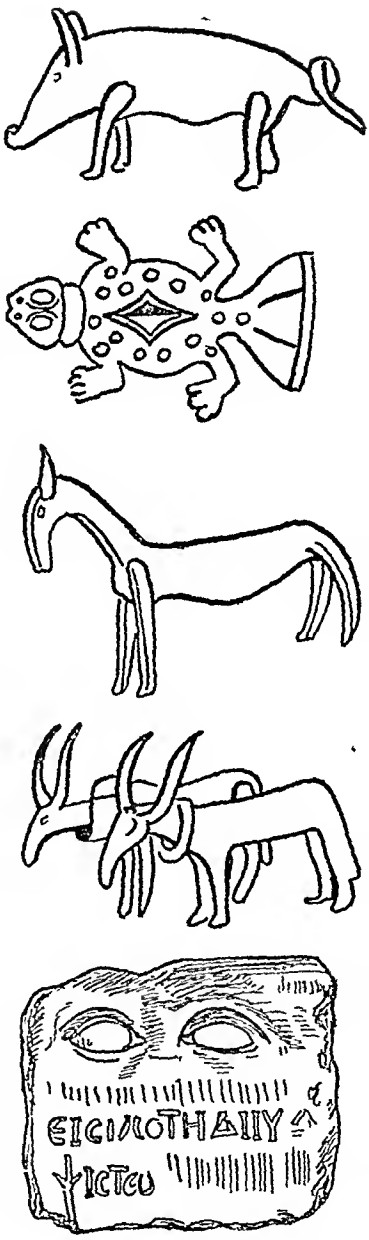
The blood of Jesus which trickled down the cross, the milk of Mary with which she had fed the infant Jesus, the tears of Jesus, the Madonna and St Peter, the toe-nails and tufts of the Holy Ghost, the skulls of the Three Wise Men of the East who were the first to

offer gifts at the birth of Jesus—all these, and many more, so-called relics, were offered for sale. Monasteries made fortunes from this trade, and exploited the gullible without the least tinge of remorse.

The Cathedral of Cologne claimed to have found relics of the Three Wise Men of the East. The Church of St Ursula was not to be out-done. A neighbouring cemetery was commandeered to produce bone relics of St Ursula and the eleven thousand virgin martyrs. It did not matter to the unscrupulous priesthood that nearly half the bones from the cemetery were obviously of men, and not of women.

Hysterical human beings paid big money for these relics, hugged them to their palpitating hearts, and even sometimes cured themselves by unbounded faith in their efficacy.

Side by side with the trade in relics, the monks and nuns built shrines, and circulated stories about their divine origin and healing possibilities. They built temples in spots where nature itself helped to heal. A medicinal spring, a forest full of valuable herbs, a cool and salubrious hill-top was ornamented with the seat of a forgotten saint or holy sage. The tired pilgrim approached the shrine with faith. He was surrounded by an awe-inspiring atmosphere of mystery. The new sight created deeper faith. Nature helped the body to cure itself, now that the mind was in league with it. Diseases based on nervous disorders were soon 'healed'. You have read, the famous novel *The Song of Bernadette* by Franz Werfel. A young girl sees visions and hears voices which prompt her to dig and find a bubbling spring of water, that cures diseases.



Votive offerings

I remember the exposition in Goa, when the coffin of St Francis Xavier was re-opened. His embalmed body was exposed to the view of thousands of faithful believers, who crowded to be cured by the mere sight of the mummy of the saint. In our own country, you will come across hundreds of similar faith-curing centres,

Healing-by-touch was practised by some of the Kings and Queens of England. It is recorded that Edward the Confessor healed a woman who was suffering from 'the King's Evil', tuberculosis of the glands of the neck. He dipped his fingers in water and rubbed the neck of the woman and the tumour was declared to have subsided. After Edward, his successors on the English throne claimed this divine right of healing.

Charles II healing by touch
(*From 'The King's Evil' by Raymond Crawford*)

The most popular 'touch-healer' was Charles II. People were often crushed to death in the maddened crowd jostling to touch his hands. The change of air, the jolts of the journey, the play of imagination, the dominating presence of the 'divine' King, the coin hung round the neck—all these were forgotten. The degenerate Stuart assumed God-like proportions. It has been calculated that no less than 100,000 invalids visited him before he died. And yet the King's Evil claimed a larger number of victims during his reign than ever before.

The practice died out with Queen Anne's death. She had 'touched' Dr Samuel Johnson when he was a child, four years old. Boswell, his faithful biographer, has recorded that Johnson suffered from the King's Evil throughout his life, in spite of the 'touch'.

The touch was not the only weapon with which the king maintained his divine origin. He gave away charms and amulets and cramp-rings. All who wore such rings were guaranteed freedom from fits and cramps of every description. It was left to Edward VI to put a stop to this practice.

Side by side with the kings and queens, charlatans appeared on the scene, and carried on the trade in human credulity as merrily as anybody before them.

Cagliostro, a blackmailer with a criminal record, announced himself as a great healer during the stormy days of Louis XVI of France. He sold chairs which were supposed to have the magic effect

of curing rheumatism for all who sat in them. He supplied beds which were supposed to make child-birth painless. He formed a secret society, and related before the choice gathering of its members fantastic stories of his conversations with Helen of Troy, and the part he had played in the Trojan Wars. He claimed to have been alive for thousands of years. His masterpiece of medical fraud was an elixir prepared by him according to 'secret instructions', received by him personally eleven hundred years before! He would make the sign of the serpent on the head of a sufferer, put a few drops of the elixir on his tongue, and the cure must certainly follow. He was clever enough to provide for failure. The cure would not occur, if your faith in the Great Cagliostro was tainted by the smallest doubt.

Cagliostro

The next impostor I want you to meet is James Graham of London. He installed the 'celestial bed' in his Temple of Health. The British Medical Journal of 1779 describes it: 'A sumptuous bed in brocaded damask, supported by four crystal pillars of spiral shape, festooned with garlands of flowers in gilded metal, are its essential features; and for a fee of fifty guineas Dr Graham offers couples, old and young, the means of getting offspring. . . one gets into this bed, hears an organ played in unison with three others. For nearly an hour while the concert lasts, one sees in the bed streams of light which play especially over the pillows. When the time for getting up has come, the magician comes to feel the pulse of the faithful, gives them breakfast, and sends them away full of hope, not forgetting to recommend them to send him other clients.'

When the hoax had been played out, Graham developed a fasting cure by which life was extended to a hundred years. He himself died before the age of fifty!

Valentine Greatrakes, the Stroker, claimed to cure people by touching them. He declared that his orders came to him in repeated dreams. The fraud was successful for a time, and then Greatrakes had to retire into obscurity.

Andrew Davis was a cobbler of New York. He expounded a metaphysical explanation for diseases, and offered cures. He successfully amassed a fortune by his clever advertising stunts.

Joseph Smith, the Mormon, was a bonesetter 'through faith in Christ'. His healing stunts collapsed when cholera swept away his devotees.

Francis Schlatter was famous in 1893, and long queues of thousands waited every day for him to touch them. He became emboldened by his success, and started posting 'blessed handkerchiefs' to his believers. The United States Government intervened, and prevented him from using the mail service for his hoax. His clientele dwindled and he was never heard of again.

Dr Elisha Perkins was a graduate of Yale College. In 1796 he announced an 'epoch-making remedy' for all diseases—his 'tractors'. The instrument was nothing more than two metal rods. All that was necessary for the cure was to place the rods in contact with each other, and move them up and down on the affected part. Dr Perkins took advantage of the ignorance of the man in the street about electricity. Benjamin Franklin had just declared that lightning was the same as electricity. Perkins attributed electric magnetism to his metallic rods. The fame of Perkins spread to the European continent, and a Perkins Institute was established in London. But the myth of the 'tractors' was soon exposed. Two pieces of wood were substituted for the metal rods, and under the well-advertised name of Perkins' Tractors did equally well.

Digby

Sir Kenelme Digby was yet another leading luminary. He produced a 'Sympathetic Powder'. An unknown saintly friar was supposed to have procured it from the mysterious East. Digby claimed he could cure a wounded man by spraying this powder on his blood-stained clothes!

Andrew Still belonged to Kansas in America. He began the cult of osteopathy. His pet theory was that all diseases were caused by a maladjustment in the spinal column. If the vertebrae

were not in their proper grooves, they crushed the nerve centres in the spine. This was supposed to cause a block which prevented the flow of 'life forces' through the nerves. This was Andrew Still's explanation for disease. Patients crowded his rooms, begging him to knock their spines into 'normality'. The osteopaths and chiropractors soon increased in number. All you had to do to earn a fortune was to handle patients roughly—but in a learned impressive manner.

Dr Gall and Louis Phillipe: character-reading from the bumps on the head

—*Cartoon*

The most celebrated bonesetter was Mrs Mapp of Epsom, London. She was popularly known as 'Crazy Sal'. An eminent surgeon of the eighteenth century has described her as 'an ignorant, drunken, female savage'. But that did not prevent her from building up a fashionable clientele and a reputation for healing by adjusting bones.

About a hundred years ago, blue glass was a rarity. Clever impostors seized on blue glass as a good means of amassing fortunes. It was claimed that blue glass had a mysterious healing quality for diseases of every kind. Screens of blue glass and windows with blue glass became the fashion. Patients were made to strip and bathe in the sunlight filtering through the blue glass. The demand brought up a greater and greater supply. Soon blue glass became very common, and hence lost its value for the quack.

The successor to blue glass was the 'electro-magnet'. Clever charlatans sold thousands of these electro-magnets. They were to be worn round the neck like life-preservers, and were attached to a light-

ed electric bulb. The magnet was supposed to attract and magnetize the iron in the blood. Little knowledge is a dangerous thing. People had vaguely heard about iron in the blood. They had also the knowledge that a magnet attracts iron. The two facts were linked together, and here was a ready basis for belief in electro-magnets.

Let us now turn to the decoctions labelled as medicine, and palmed off as cures. You will have realized that all the above instances are of people who pretended to cure by dealing with the patient externally. Now let me recount the much more dangerous practice of charlatans who pretend to cure by 'patent' drugs—the sacrosanct modern monstrosities which are allowed to be sold in our markets with legal sanction.

If a thing was rare or unusual or new, the charlatan attributed fantastic healing powers to it. Gold dissolved in acid, musk, crocodile dung, pearls, flesh of poisonous vipers, crushed sow bugs and lice, incinerated toads, eunuch's fat, moss from the skull of a hanged criminal, the rope with which the man was hanged, human blood, powder from Egyptian mummies, a unicorn's horn (a fabled animal that never existed), bezoar-stones, soles of old shoes, and even the potato when it was newly introduced—all these have ranked as sovereign remedies. Even excrement and urine have taken pride of place in the quack's prescriptions. Madame de Sevigne in the seventeenth century, and Fauchard the dentist in the eighteenth century recommended urine as a remedy for pains in general and even as a mouth-wash for tooth-ache.

In his *Natural History*, Pliny has attributed magical qualities to menstrual blood. It was considered fatal to insect pests; it was reputed to calm the worst storm in all the seven seas!

The famous Cardinal Richelieu was given horse-dung in white wine on his death-bed.

Pope Innocent VIII is reported to have been fed on the blood of three new-born children in order to cure him of his malady.

When Charles II of England, who himself claimed to heal by touch, was on his death-bed, nearly a dozen 'healers' of the land gathered to save the life of the king. You will have some idea of the ignorance and superstition about drugs in those days, when you read the historical record of the treatment meted out to him.

'At eight o'clock on Monday morning of 2 February 1685, King Charles was being shaved in his bedroom. With a sudden cry he fell backward, and had a violent convulsion. He became unconscious ....As the first step in the treatment the King was bled to the extent

of a pint from a vein in his right arm. Next, his shoulder was cut into and the incised area 'cupped' to suck out an additional eight ounces of blood. . . An emetic and purgative were administered, and soon after, a second purgative. This was followed by an enema containing antimony, sacred bitters, rock salt, fennel seeds, linseed, cinnamon, cardamom seeds, saffron, cochineal and aloes. The enema was repeated in two hours, and a purgative given. The King's head was shaved, and a blister raised on his scalp. A sneezing powder of hellebore root was administered, and also a powder of cowslip flowers to strengthen his brain. The cathartics were repeated at frequent intervals, and interspersed with a soothing drink composed of barley water, licorice and sweet almond. Likewise white wine, absinthe, and anise were given, as also were extracts of thistle leaves, mint, rue and angelica. For external treatment a plaster of Burgundy pitch and pigeon-dung was applied to the King's feet. The bleeding and purging continued, and to the medicaments were added melon seeds, manna, slippery elm, black-cherry water, an extract of flowers of lime, lily-of-the-valley, peony, lavender and dissolved pearls. Later came gentian root, nut-meg, quinine and cloves. The King's condition did not improve, indeed it grew worse, and in the emergency forty drops of extract of human skull were administered to allay convulsion. A rallying dose of Raleigh's antidote was forced down the King's throat; this antidote contained an enormous number of herbs and animal extracts. Finally, bezoar-stone was given. As a sort of grand conclusion to this pharmaceutical debauch, a mixture of Raleigh's antidote, pearl fillip, and ammonia was forced down the throat of the dying King. King Charles was helpless before the drugging of the physicians, who wished to leave no stone unturned in his treatment.' No wonder King Charles died, sinking like a ball of lead to the bottom of life's abyss.

Benefits of blood-letting
(*Woodcut*)

To bleed doth cheer the pensive and remove
The raging fires bred by burning love.

It took science years and years of patient experiment before man's medical obsessions, clouding his rational mind, were discarded.

Before I close this letter, I must clarify a doubt which might arise in your mind about the faith-cures that some of these charlatans

achieve. That they could heal sometimes, in spite of their unscientific remedies cannot be denied. How and why, is the question.

You must realize that all diseases can be classed under three heads:

Diseases which cure themselves.
Diseases which are brought on by mental obsessions.
Diseases which are physical, and need science and the physician to cure them.

Our human frame is so adjusted that minor disorders such as stomach-aches, due to over-eating, diarrhœa, due to indigestible foods, or colds of a mild character, can be fought off, if the body is given a chance to heal itself. In such cases the charlatan claims the cure which the patient's own body effects. Disease is conquered, not because of the quack-remedy, but in spite of it.

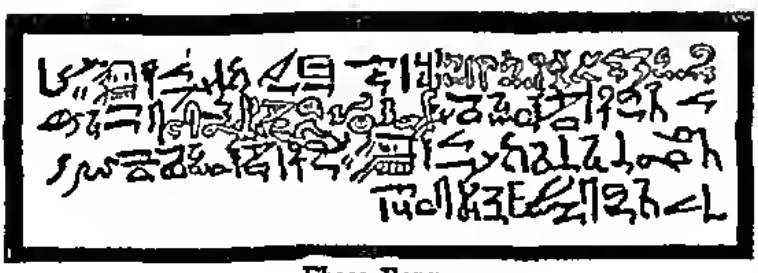
Paralysis is often brought on by a mental shock. The war has provided us with many cases of shell-shock' They are often amenable to the 'faith' tactics of charlatans and touch-healers.

But cases in the third category—malaria, tuberculosis, cholera, small-pox, plague, diabetes, cancer, syphilis, anæmia, diphtheria, typhoid—can never be cured by the mumbo-jumbo practised by these direct descendants of the medicine-man The faith-healer and the drug charlatan would be equally unsuccessful with patients suffering from a disease caused by microbes.

In the letters that follow I shall attempt to give you a glimpse of the herculean efforts made by scientists to conquer these microbes and the diseases caused by them

When you place an empty shell to your ear, you think you hear the roar of the distant sea. When you hug the remedy of a quack to your ailing body, you think you are healing your malady. The one course is as futile for reaching the sea as the other is for attaining health. If you are wise, you will pursue neither course

Yours affectionately,
MASHI



Ebers Papyrus

A remedy to nullify all magic spells—
Cut off the head and both wings of a large beetle, heat it together with fat, and apply it. Then if you wish to expel it, heat the head and both wings with snake fat, and let the person drink it.

Road builders' homes in Bombay suburbs

'Is Man born to this estate?' Milkman's home in Bombay City

Food being sold near a refuse dump in a Calcutta bazaar

LETTER IV

THE UNIVERSAL FOE: MALARIA

LINA AND VIJAY,

The fever which killed Rahoul's father was malaria. Malaria kills more people in our country than any other disease. At least one million die every year, and a hundred times that number become weakened by this fever, so that they become easy prey for any other disease that may sweep our unhappy land in the form of an epidemic. The tragedy is greater because malaria has definitely been conquered by science in the civilized countries of the world.

I shall tell you the story of malaria.

The history of malaria can be read from some of the oldest books we have today. As far back as the fifth century before the birth of Christ, a great healer by the name of Hippocrates has mentioned the symptoms that are associated with malaria fever. After him, the great Galen and Celsus have given their testimony about its existence. At one time, the mighty Romans had been so weakened by the ravages of malaria that the barbarians from the German forests, the Goths and the Vandals, could loot and defeat them. Alexander the Great is said to have died of malaria. In comparatively recent times, Cromwell died because he could not get quinine.

Hippocrates

Malaria is not easy to distinguish from other fevers. It was only in 1640 when the cinchona plant was introduced into the Western world, and two doctors Morton and Tort, used it to cure this fever, that it became possible to segregate malaria.

Even then, millions died of malaria, because nobody knew how the fever was contracted. All kinds of theories were put forward, but nobody could find-out the real cause of this dangerous disease.

In the year 1847, Meckel is dissecting the dead body of a man

who died of malaria. 'Ah-ha! This is something new!' He has found a coloured surface inside the spleen. He rushes to his microscope. 'The spleen has a whole layer of pigment-bearing cells, such as I have never seen in the case of other men. Let me look at his blood.' The lens of the microscope focuses now on the blood-slide. There is something new here too, something which he has never noticed in the blood of men not suffering with this fever. He makes a guess: this must be the germ which killed the man—this must be the malaria parasite! A blind man is stretching out his hands to feel the wall!

Galen

In 1880, exactly thirty-three years later, Laveran, a French Army Surgeon, after repeated experiments with the microscope, definitely establishes the parasitic nature of malaria. Golgi, another scientist, proves, by constant observation, the co-relation between the growth of the parasite and the repetition of the fever after a regular interval.

Scientists are hard at work. But as yet the advance recorded is limited.

The peasants of North Italy have suffered from the ravages of malaria for centuries. They have a vague belief that the mosquito has something to do with the tragedy.

A scientific investigator by the name of Koch records a similar belief held by the natives in the mountainous regions of East Africa. They call the mosquito Mbu, and malarial fever is also known as Mbu.

Yet nobody really knows the true role that the mosquito plays in malarial fever. People suspect that the bite of the mosquito must be poisonous. That is all. They have no proof of it. Their guess is due to the fact that mosquitoes abound in those regions where malaria is rampant.

Manson is the first to put up a scientific hypothesis. He takes up the thread of Laveran's theory, and declares that the malarial parasite must pass from host to host in order to grow and keep alive. He closely observes men suffering from malaria. He finds that this parasitic germ does not leave the body either through the excreta or the sputum or in any other way. It is enclosed in the blood-cell, and as

it cannot get out by its own efforts, Manson reasons, there must be a blood-sucking creature which extracts this parasite, stores it up within itself, and nurtures its growth. Manson has a theory of his own about it: the mosquito 'sucks the worms out of the blood of sick Chinamen', and these are the worms which later develop in the stomach of the mosquito. His imagination runs away with him. 'A mosquito can bite only once, and then must die,' he declares. How did a healthy person get malaria? Manson believes it is possibly by drinking dead mosquitoes or inhaling the dust of mosquitoes that a person gets malarial fever.

Ronald Ross

Now Ronald Ross enters the battle against malaria.

Ross has an interesting past. He was born in India at Almora, in the shadow of the Himalayan Mountains. His father was an army man, a General, who had a flair for painting. Young Ronald wrote poetry, composed music, tried his hand at literature—did everything except concentrate on his medical studies. Father Ross was very angry with him, and threatened to stop his allowance. So Ronald quickly passed his final examination and became a ship's doctor, plying between London and New York. Soon he passed his Indian Medical Service examination, and came back to India. Once again his mind refused to concentrate on his profession. He started learning mathematics and writing novels for a change. He invented systems of shorthand-writing and also devised phonetic spellings.

His restless spirit found a new channel of activity—the microscope. Our interest in Ross begins at this point. Aggressive and impatient by temperament, he straightaway publishes four papers to prove that malaria is caused by intestinal disturbances, and Laveran was wrong about the malaria microbe.

Of course, Ross himself is quite wrong. But he is too obstinate to see the point of Laveran's theory.

At the age of 36, in 1894, he gets tired of medicine and wants to give up his profession. He goes to London on leave and here he meets Patrick Manson, who too has come back from the East—Shanghai. This proves to be a fruitful meeting. But for Manson and

his encouragement, Ross would never have concentrated on the study of the mosquito and helped to solve the malaria mystery.

Manson is obsessed with the idea of mosquitoes. He has a hunch that the man who masters the details about the lives of mosquitoes, would be able to contribute to the well-being and happiness of mankind. He is so obsessed by his pet theories that he has become the laughing-stock of the expert physicians who honour Harley Street in London. They call him 'Pathological Jules Verne'. But the faith of Manson is made of stern stuff. He talks to every man he meets about the importance of studying the mosquito and its habits.

Now Manson meets Ross and naturally they talk about the mosquito. Manson convinces Ross that he is mistaken about Laveran, that the malarial parasite is a real thing. Manson examines the blood of sailors just back from a long voyage to the East. He shows Ross how the coloured spots in the blood turn into spheres inside the red blood-cells. They later burst the cells and become crescent-shaped, and then put out long arms—sometimes two, sometimes as many as six—which frantically move about like those of an agitated octopus.

'You will never find these malaria parasites in the blood of healthy people,' says Manson. 'I want you to help me to find out how these very parasites get to the blood of other men—how they travel from these sailors to others not suffering from malaria! This is my problem,' he tells Ross.

Ross is an ignoramus about the mosquito. He does not even know that mosquitoes are gnats. He searches for books on mosquitoes all over London, but never thinks of looking inside the British Museum. Nevertheless, with his customary self-confidence, Ross sets out on the trail of this enemy of mankind. He leaves his wife and children behind him in England, and sails for India on 28 March 1895.

Manson has infected Ross with the mosquito-mania. Ross begins to pester his co-passengers on the boat to let him prick their fingers and examine their blood.

Once in India, Ross is posted to Secunderabad, and incurs the displeasure of everybody, high and low. His superior officers take him for an upstart, and the lower-paid Indian workers go in fear of the 'pricks for blood' that he demands from them.

An accident occurs, which would have proved fatal for a less tenacious man. Ross is challenged by his co-doctors to prove the existence of the malaria microbe. He selects a Hindu patient who has been a chronic sufferer from malaria, pricks his finger, takes a drop of blood

on a slide and puts the slide under the microscope. Horror of horrors! There are no malaria microbes to be found! Ross becomes the object of their ridicule.

Caricature of Ronald Ross
(*Mauritius Paper, 1908*)

Ross, however, is not deterred. He keeps on collecting mosquitoes, even though he does not even know how to distinguish one kind of mosquito from another. He lets them loose on poor Indians, whom he strips and puts under a mosquito-net. 'They are stubborn as mules,' Ross writes to Manson, when the mosquitoes refuse to bite the victims. And yet, they do bite when he deluges the net and the victim with a bucketful of water. He catches the well-fed mosquitoes, and cuts them up one by one to see if the microbes of malaria are growing inside the mosquito-stomach. But he finds nothing.

He describes in a long letter to Manson a great battle between a malaria microbe and a white blood-cell: 'He kept poking the white blood-cell in the ribs, in different parts of its body, until finally the cell turned and ran off howling.... One could write a novel about it in the style of *The Three Musketeers*.' Ross becomes poetic in his description of humdrum operations on the stomachs of mosquitoes and about what he sees through his microscope.

Caricature of Ronald Ross as a Pied Piper to mosquitoes

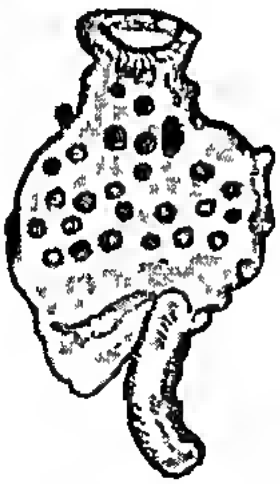
Then Manson suggests a new experiment: 'Let mosquitoes bite a malaria patient; then leave the mosquitoes in a bottle of water, and let them lay their eggs in it. Then give the mosquito-water to somebody to drink, and observe the result.'

Ross gets Lakhsman, his valet, to drink the mosquito water.

Lakhsman gets high fever all right, but it is not malarial fever. Ross repeats hundreds of experiments. He writes, 'There is only one method of solution, that is by incessant trial and exclusion'. But he is not able to locate anything tangible.

Ross flies into a temper when he learns about his transfer to Bangalore. He is asked to try and stop a cholera epidemic. Ross goes to Bangalore but is not in a position to check the epidemic. He boils with rage against the authorities. He writes, 'I wish I might rub their noses in the filth and disease which they so impotently let fester in Hindustan'. Quite a lot of his anger is legitimate. The appalling neglect and lack of scientific knowledge that Ross witnesses everywhere is sufficient to merit a stronger indictment.

For two years Ross remains away from Secunderabad, and many a time he is driven to desperation. He wants to throw his microscope out of the window. In June 1897 he is once again installed in the Begumpet Hospital at Secunderabad. He restarts his experiments right from the beginning. He searches out his long-suffering patient Husein Khan, strips him and puts him under the net in company with mosquitoes of a new variety. It is the 16th of August 1897. Ross unfortunately does not know the classification of mosquitoes and he makes an entry in his note-book against them, 'Brown mosquitoes'.



Malaria spores in mosquito stomach

One by one the mosquitoes which feed on Husein Khan are cut open by Ross, and put under the lens. He spaces them out, so that he has a mosquito for each succeeding day. On the 19th, there are only three left. It proves to be a memorable day for Ross. As he peers down the lens at the stomach of the mosquito, he spots a peculiar round object, a tiny dot of an object about a twenty-five-hundredth of an inch in diameter!

On the 20th, another mosquito, and the same result, but with this difference that the object is clearer. Could it be growing? Can this be the malaria parasite now growing inside the stomach of the mosquito? Ross wonders: 'Those circles in the wall of the stomach of the mosquito—those circles with their dots of black pigment—they can't be anything else but the malaria parasite growing there...That black pigment in the microbes in the blood of Husein Khan!...The longer I wait to destroy my mosquitoes after they have sucked his blood, the bigger those

circles must grow. If they are alive, they must grow!'

The 21st confirms everything. In the last mosquito cut open on that day, Ross counts no less than twenty jet-black dots.

Ross bursts into poetry. He writes a verse to commemorate the occasion:

I have found thy secret deeds,
Oh Million-murdering death!
I know that this little thing
A million men will save.
Oh death, where is thy sting?
Thy victory, oh grave?

While Ross is desperately searching for more brown mosquitoes, the authorities transfer him again, this time to the north, where the colder climate does not allow many mosquitoes to breed. Those which Ross catches refuse to bite. The local inhabitants are shy and superstitious, and refuse to allow him to prick their fingers for blood.

So Ross writes angry letters to everybody. At last the efforts of Manson succeed. Ross is sent to Calcutta. Here he finds a laboratory ready for him. He meets Mahomed Bux, without whom he could never have completed his discovery. There are millions of mosquitoes and hundreds of patients suffering from malaria in Calcutta. This is Ross's dream come true.

Mahomed Bux visits foul-smelling tanks and sluggish drains and the sewers of the city of Calcutta. He collects all varieties of mosquitoes, from brown to dark green. Mahomed Bux has a way of cajoling the mosquitoes to bite the victims inside the nets spread by Ross. However, the experiments are a series of miserable failures once again. This makes Ross doubt what he has seen at Begumpet. Can it be due to the heat and fatigue that he saw visions of microbes inside the mosquito-stomachs?

Then Ross gives up torturing human beings and concentrates on birds. Ross thinks that the malaria microbe in birds looks very much like the malaria microbe in men. Mahomed Bux now ensnares birds. Three larks are caged and protected by a thin net. Then ten gray mosquitoes are allowed inside the cage to feed on the malaria-ridden blood of the larks. Three days pass and the mosquitoes are cut open and their stomachs put under the lens. Look! the microbes are there. Ross feels a happy man. His experiment has at last succeeded. He can now write: 'The microbe of malaria in birds grows in the wall of the stomach of the gray mosquito, just as human microbes grow in

the wall of the stomach of the brown spot-winged mosquito.'

Ross measures the growth of the microbe. He finds that it increases from about one-seven-thousandth of an inch after thirty hours to about one-seven-hundredth of an inch after eighty-five hours.

Ross now turns to sparrows, and selects three. Mahomed Bux sees to it that the first is free from malaria, the second has only a few microbes, and the third is teeming with them. They are installed in separate cages with mosquito-nets. Mahomed Bux now raises a whole brood of mosquitoes from grubs guaranteed to be free from malaria microbes. A flock of them are let loose into each bird-cage. The result is revealing. When the mosquitoes from the first cage are dissected, not one of them has the dotted circles in its stomach. Those from the second cage have a mild infection. The third-cage mosquitoes are all heavily infected, as heavily as the blood of the sick sparrow itself. As the interval between the bite and the killing of the mosquitoes lengthens, the black dots also swell and grow, till they resemble distinct warts. Inside the warts, little bright-coloured specks collect like sand in the desert.

Ross has yet to solve the mystery, how are these malaria microbes from the stomach of the mosquito transferred to new birds, how is the poison passed on? Ross has traced the microbe from the sick bird to the mosquito, and observed its growth inside the mosquito itself. But once the poison is ripe within the mosquito, how is it given to the next victim, that is now the problem.

Ross works in spasms. Just when he is on the threshold of his discovery, he goes away to Darjeeling. He is easily elated, and then as easily becomes depressed, and in a mood of despair throws up everything. Yet the scientist in him ultimately conquers this weakness, and drives him back to the laboratory.

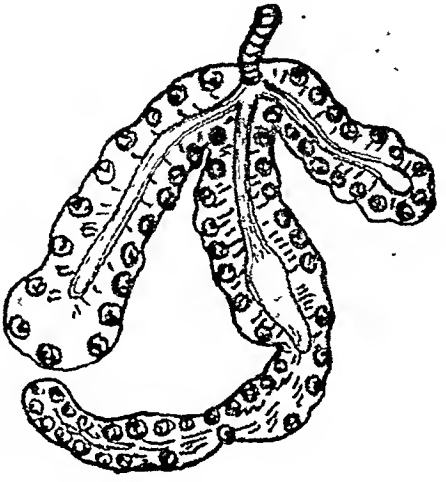
In June 1908, with the temperature at 100°F, he bends over his microscope again. He begins a minute examination of the warts on the stomach-walls of the female mosquitoes. After dozens of failures, he finally finds that with further growth the warts break open, and thousands of queer spindle-shaped worm-like threads rush out, and begin to circulate throughout the body of the mosquito. Day after day, for months, he is at the microscope, looking at the cycle of development of these warts. Ross is stumped here. He cannot find out what happens after this point is reached.

There is an old proverb—Patience and perseverance overcome mountains. Ross tries to be patient, and sticks to his microscope. At last he is rewarded. He sees myriads of malaria microbes moving

Children in an orphanage in Orissa. The little girl on the right was picked up in a village street by relief workers during the Orissa famine

Compassion alone will not help her. A woman suffering from epidemic dropsy which swept across Bengal and Orissa after the famine in 1944

to the salivary gland of the mosquito, ready to be injected into a fresh victim through the stinger. Here is scientific proof at last: 'It is through the bite of the mosquito that the malaria parasite is spread from one victim to another.'



Malaria spores in mosquito salivary glands

Ross is careful. His 'teacher', Patrick Manson, never foresaw this. Manson thought that dead-mosquito water or the dust of mosquitoes gave malaria. So Ross repeats his experiment over and over again. He experiments on healthy sparrows with mosquitoes swarming with malaria microbes in their spit-glands. There is no room left for doubt: the poisoned mosquitoes are the carrying agents of malaria. Once sure of his ground, Ross writes to Manson and to Laveran in Paris. He freely dispatches copies of his thesis to medical journals. Ross now constantly talks to everybody about his discovery. He assumes the role of an advertising agent.

Manson takes up the matter with the Medical Congress at Edinburgh. The Congress, after a lot of wrangling, congratulates Ross on his 'great and epoch-making discovery'. They think that what has been discovered with birds automatically applies to men. The Congress is on a false track, just as Ross himself is misled in his belief. Manson is sceptical. He warns Ross: 'One can object that the facts determined for birds do not necessarily hold for men.' Ross wants to leave India and return as a 'conquering hero' to England, to Europe, to the whole civilized world. Manson tells him this is futile; he must stick to the microscope and the steamy Indian climate, and keep on the trail of the mosquito. But the ignorance of Ross about the different kinds of mosquitoes is so abysmal, that it is not possible for him to progress beyond his discovery. He has blazed a trail. He has lighted a torch. It requires Giovani Batista Grassi to carry the torch further along the trail, and lead mankind out of the deathly swamp of malaria.

That is the story of Ross.

Scientists have not only to be patient men, but learned men as well. Failure dogs their steps day after day, and year after year. Then for a fleeting moment they get the glimpse of a natural law. Once again the horizon darkens. Yet, the true searcher after nature's mysteries must go on working tirelessly. He must persevere inside his laboratory ceaselessly.

His patience may be rewarded by blinding success, or may just help to keep the torch of investigation and knowledge alight and burning. Glory or honour may come or may not. Progress—scientific progress—demands great application, steadiness, systematic work, and above all a devotion to knowledge. The life of a scientist is hard. Without him and his silent sacrifice, mankind would not be able to triumph over the obstacles that nature places in the path of progress. Ross was successful because he was persistent and hard-working. Ross was lucky to earn the praise of his fellowmen in his lifetime. But it did not make him give up his gruelling labour in the laboratory.

Yours affectionately,
MASHI

LINA AND VIJAY,

In this letter we shall examine the part played by Grassi in the fight against malaria.

In science, as in the field of every progressive step that society takes, the work of one investigator becomes the starting point for another. No one man can hope to unravel everything in one lifetime. Nature's mysteries are unfolded layer by layer, and it takes the unselfish labour of many men to keep on the march and successfully scale one obstacle after another.

Grassi takes the discoveries of Ross as a working data. The medical-man plus the zoologist goes ahead and reaches the goal, which Ross failed to do.

Grassi has many qualities which Ross lacks. He is precise to the point of being meticulous. He is as patient as an iceberg. He is thorough and painstaking in whatever he undertakes. He is a hard worker and hates everyone who idles. 'Mankind is composed of those who work, those who pretend to work, and those who are just idlers and burdens to society,' he always said.

He studies the ways of ants and eels. Whatever he does, he does intensely. His application is so great that he soon knows more about white ants and eels than any other living human being. The surprising part of it all is that his eyesight is very bad and most of his work is minute observation of insects through the microscope.

He is a scholar and attains the status of a professor when he is only twenty-nine years old. Grassi has an idea that mosquitoes carry malaria. But his first experiments fail—like those of Ross—because he uses a harmless mosquito. He leaves his experiments on the mosquito in order to make experiments on other insects. The Italian people approach him again and again : ' Malaria is the deadliest enemy of Italy. It desolates our rich farms, and it attacks millions of our workers in the lush lowlands. You must help us, Signor Grassi! '

Grassi is a great patriot, and jealous of the honour and well-being of his own country. So he decides to concentrate on the malaria microbe. Then occurs a chance meeting between Grassi and Robert Koch, the ' Uncrowned King of Microbe-Hunters '. They have a long discussion.

Grassi: You believe that the mosquito carries malaria. I can show you miles and miles of land in Italy where mosquitoes are thick as clouds on a rainy day, but there is no malaria.

Koch: What does that prove?

Grassi: That mosquitoes do not necessarily give malaria. The cause of malaria may lie somewhere else.

Koch: Is that all you have observed?

Grassi: I must confess, that in every place where there is malaria, I have always found mosquitoes. That is in your favour.

Koch: So what is your conclusion?

Grassi: Either malaria is carried by one special kind of blood-sucking mosquito—and there are easily twenty to forty kinds of mosquito—or the mosquito is innocent of the charge!

This conversation does not result in joint work by these two eminent searchers. It only succeeds in giving Grassi fresh incentive for further investigations. He writes, 'Mosquitoes without malaria, that is possible; but malaria without mosquitoes, never. Therefore let me go through all the different varieties of mosquitoes, let me eliminate them one by one, and I might find the culprit!'

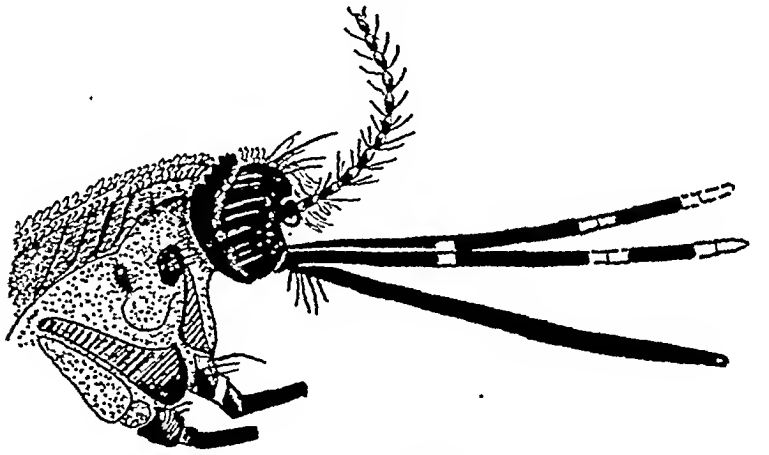
It is a brave decision. It involves laborious and tedious work. So Grassi sets about it with a will. He is a systematic man. He thinks out his plan of attack before he launches into a campaign. He reasons: 'What does a policeman do when he has to locate the criminal in a village murder? He certainly does not examine every villager. There may be a thousand men and a thousand women in the village. His work would be endless. He adopts another method—first he rounds up the criminals, all suspected ones—and begins his investigations. So will I begin too.'

He is lecturing at the University of Rome in the fateful year 1898. As soon as the vacation comes around, he packs up his clothes, takes some test-tubes and note-books, and marches to the hot marshy districts of Italy. He chases mosquitoes all through the hot vacation in filth-heaps and in impossible swamps, armed with his test-tubes. He looks for them under beds, buzzing round garbage piles in saloons, and even inside churches. He collects some two dozen varieties of mosquitoes. He carefully opens them up, puts them under the microscope, and declares them innocent of the crime of carrying malaria: 'The law of science finds you not guilty! You bite babies in beds, Fathers and Nuns in churches, and drunkards in saloons. Yet your bite does not give them malaria. You are set free!'

Now Grassi is obsessed by the hunt. He pokes his test-tube here, there and everywhere. He enters houses unasked, wherever malaria rages. He asks the inmates a volley of questions: Is there

anybody sick with malaria in your home? What kind of mosquitoes bite your baby? Did you count the bites before the fever appeared? Is there anybody who did not get malaria after the bites? And so on untiringly. If the house-owner says that the fever came without any bites, Grassi goes into room after room and begins a search for mosquitoes. Sure enough he finds them behind the image of Christ, or beneath the bed, or even inside the shoes. He is indefatigable with the scrawls in his note-books. Before he returns to his laboratory in Rome, he is convinced about one thing: wherever he has found the mosquito, which is popularly called 'Zan-za-ro-ne', there malaria takes a definite toll. People die in hundreds, the fields are left untilled, schoolrooms are deserted or at best filled with pupils who have records of extremely irregular attendances.

Grassi keeps on the track of the Zan-za-ro-ne like a sleuth-hound. He finds that these female mosquitoes live in the marshes all day



Mosquito head

and visit the neighbouring towns at night. The lights in the town are the meeting-grounds. The Zan-za-ro-ne is delicately made, and Grassi whispers to himself: 'Why, she is pretty and elegant. These four dark moles on her light-brown wings make her very attractive indeed. And look at the peculiar way in which she sits, with her tail raised like a peacock's umbrella behind her... And she is discriminating in choosing her victims. She prefers the big and the fat ones to the small and the lean ones. She prefers a horse to a man, and a man to a rabbit... This Zan-za-ro-ne is my old friend, no other than Mrs Anopheles Claviger, as we know her in the world of science.'

Grassi decides to experiment on himself. He locks himself up

in his bedroom, puts on his night shirt, and lets loose a box-full of Zan-za-ro-ne. They all fly out of his window. His experiment is a failure.

Nevertheless, so sure does he feel about his findings, that he writes a paper and reads it before the Academy of the Lincei in Rome: 'If any mosquito carries the malaria microbe, it is the Anopheles. I am not sure about two other kinds of mosquitoes. But the rest of the varieties are all harmless.'

Koch publicly laughs at these conclusions. Then Grassi begins a series of new experiments. He gets hold of one Signor Sola, a healthy man, and persuades him to be experimented upon in the interest of science. Signor Sola is tortured every night; each night a fresh brood of hungry female mosquitoes is let loose on him. Yet nothing happens. Signor Sola keeps hale and hearty, none the worse for his nightly meetings with the she-mosquitoes.

At last comes the turn of the female Anopheles mosquito. That night Signor Sola is particularly restless. Ten days pass, and Signor Sola develops high fever, preceded by shivering. His blood now shows a swarm of malaria microbes.

Grassi has gained his point. He records: 'The rest of the history of the Sola Case has no interest for us, but it is now certain that mosquitoes can carry malaria to a place where there are no mosquitoes in nature, to a place where no case of malaria has ever occurred, to a man who has never had malaria—Signor Sola.'

Grassi repeats the experiment on man after man. The press raises a howl of protest. Grassi is not to be deterred. He has only one idea, and in the pursuit of it, he forgets his softer nature, his cultural heritage. He actually rejoices when the patient begins to shiver and develop high fever. He gives quinine to him only when *he is convinced that it is his pet Zan-za-ro-ne that is responsible for* the fever. After that, he drops the patient like a hot potato. He has no more interest in the human beings who help him to become world famous.

When Grassi reads about the discoveries of Ross, his first reaction is: 'Crude stuff!' But when he tests the process on his Zan-za-ro-ne, he finds that Ross is right, that the Zan-za-ro-ne picks up malaria microbes from a malaria patient, develops them in its own body, the warts burst, the spindle-shaped threads float to the spit-glands, and then the stinger finally injects them into the new victim with a long kiss, which leaves an itching sensation behind.

Grassi has proved that malaria cannot travel directly from man

to man, as other fevers do. He establishes that a fresh generation of Zan-za-ro-ne, born of parents who carried malaria microbes, is itself quite innocent and harmless, till it bites a malaria patient. The Zan-za-ro-ne is not a hereditary malaria pest. Grassi also proves that the mosquito which carries malaria to birds is a different variety from his Zan-za-ro-ne, and cannot infect man.

But Grassi is not merely a scientist; he is also a reformer. He now brings all his zeal to bear on the problem of cleansing his native land of the malaria scourge.

He organizes campaign after campaign, throughout the country. He shouts from the house-tops: 'Keep away the Zan-za-ro-ne, and in a few years Italy will be free from malaria!'

He issues commandments: 'Do not walk at twilight in the open; wear gloves and veils and cover your legs, if you must stir out after the sun has set.' Few bother to listen to him. He is ignored by the majority of men.

Grassi falls back on the wisdom of his ancestors: one good example is better than a thousand sermons. 'One family remaining free from the tortures of malaria—that would be worth ten years of preaching; I'll have to show them,' he mutters to himself.

He selects for his experiment the plains of Capaccio, the most malarial region in Italy. In the hot months, whoever can run away from these parts, makes good his escape from the annual malaria epidemic. Grassi selects ten houses of station-masters and other railway workers. He bars the doors and windows with wire screens, screens with holes which do not permit the thinnest Zan-za-ro-ne to slip through. The Queen of Italy patronises Grassi, and the railway authorities give him full powers to control their workers as he likes. Grassi takes full advantage of the authority vested in him, and once again issues his commandment: 'Thou shall not move out of doors after sunset, however enticing the twilight may be.'

The domain under Grassi's rule consists of one hundred and twelve human beings inhabiting ten houses. Grassi pleads with them, tempts them with prizes, and finally threatens them with reprisals, if they break a single law of his.

This is a particularly bad year for the Italians so far as malaria is concerned. Mosquitoes multiply in millions, and the unscreened houses, with their population of four hundred and fifteen sufferers, pay a heavy toll. Almost to the last child, they all become victims of malaria. The hundred and twelve followers of Grassi work in the open all day, breathe the same air as the other inhabitants, drink

the same water, and do everything which the scientists have previously declared would possibly give them malaria. They only avoid two things: stepping outside their wire-netted houses at night and keeping their doors and windows open for the Zan-za-ro-ne to enter. During the whole summer only five get malaria; these too are cases in which the fever is mild. Grassi says they are relapse cases from the infection of the previous year.

Grassi has conclusively proved his words. The Italian world stands up and applauds him as their saviour. He it is who has found the way to prevent malaria. He has done it by risking his own life in the most infected spots Italy honours Grassi by conferring on him the distinction of being a Senator for the rest of his life.

Ross is still more lucky. He wins the Nobel Prize of seven thousand eight hundred and eighty pounds sterling, and banquets are given in his honour. Ross and Grassi never become friends. They hate each other, and both think that the other one has stolen his theories. They even sink to the level of calling each other names. Of course they are very wrong and very unscientific in this. Science and the unravelling of the mysteries of nature are much greater than the scientist himself Whether an individual discoverer is appreciated or not does not matter to society as much as the discoveries themselves. A true son of science, in a society which is really enlightened, keeps on searching, and does not harbour petty jealousy or indulge in quarrels over the laurels that follow achievements.

So ends the chapter of Ross and Grassi, which begins so brilliantly, and ends on the sad note of personal enmity. History will only remember their scientific achievements, pay homage equally to both, and pass on to newer men who serve society by fresh discoveries.

Yours affectionately,
MASHI

LETTER VI

LINA AND VIJAY,

Since the days of Ross and Grassi, malaria research has made great progress. Today we know many more facts about the way the fever spreads and the way it can be avoided. Yet malaria claims one in every four human beings in the world as its victim. It is still one of the biggest health problems facing medical men and scientists.

In World War I we find malaria the chief scourge of invading armies. No less than three hundred and fifty thousand soldiers in the British Army—of whom Indian soldiers formed a large proportion—became very ill from malaria in the Near East and the East African campaigns.

The word 'malaria' is derived from a Latin word meaning foul air. Millions of our poverty-stricken countrymen are being daily poisoned by this 'foul air', killing, maiming and destroying their lives every year. When plague or cholera epidemics rage in our country, the loss in human lives is astounding. But once the epidemic has been fought against and stamped out, there are no after-effects left. The population that has been saved reverts to its normal occupations. But the scourge of malaria not only brings death in its wake; it continues to pester the living—weakening and demoralizing them every few days over a period of months and years. There is a marked deterioration, physical and mental, in a race which suffers from malaria continuously. It saps the strength of the farmer, and he neglects agriculture; it saps the energy of the labourer, and he proves to be an inefficient worker; it saps the mental activity of an intellectual, and he is reduced to narrow grooves, superstition, petty-quarrels and general backwardness. Unborn children are throttled to death; women are rendered barren; youth is shrivelled up into premature old age—by the single curse of malaria. It brought about the debacle of the splendour that was Greece, the decline and fall of the Roman Empire, and the disappearance of Egyptian civilization and the ancient culture of Ceylon.

In our country, fertile land remains unexploited, mineral wealth is left untapped, many a plantation of tea, coffee and rubber is abandoned—mainly due to malaria.

Experts have found out that in the United Provinces, one in every three human beings is incapacitated for at least four months in the year. All over India, no less than a hundred million suffer from the ravages of malaria, out of which one million die. The figure rises to

a million and a half, if malaria assumes the form of an epidemic As recently as 1931 it killed five times more people than cholera plague and small pox—all three scourges put together

The expectation of life in India has withered away to twenty seven years, compared with sixty in Great Britain Only a hundred and eighty six persons out of every thousand reach the age of fifty, whilst in England every second man lives up to that age In the highly malarious district of Kanara there are only forty one men out of every thousand of the age of fifty years and more

And this is not all

Lt Col Sinton, once Director of the Malaria Survey of India, has computed that the financial loss to the Indian nation due to malaria alone, amounts to eleven hundred million rupees annually!

Malaria undoubtedly breeds poverty, and poverty, in its turn, breeds and perpetuates malaria The vicious circle is complete, with ignorance, emaciation, anaemia, and lack of initiative and enterprise, joining the chorus in the mad whirl of poverty and disease

Malaria is more formidable than the worst human tyrant history has ever produced It has effectively enslaved and crushed nations much more effectively than human ingenuity and conspiracy could encompass This tyrant has got a million arms and an insatiable appetite The arms reach into the farthest huts in the most secluded villages of our vast land Its appetite grows with every successive generation of the Anopheles mosquito

If India is to occupy its right status in the life of civilized nations, malaria must be stamped out 'Quit India' will have to be applied to Mrs Anopheles Mosquito, too

You will ask, 'What is the best method of combating this disease?' The fight against malaria has to be three fold We must *cure persons suffering from the fever, and its repeated attacks*, we must take preventive action against being bitten by mosquitoes we must attack the link between the malaria patient and the future victims

Medical science has found that quinine is an effective drug to bring malarial fever under control, even though the traditional belief that quinine can cure all fevers, is baseless and false

The history of quinine is interesting, and you must know it Quinine is prepared from the bark of the cinchona plant The Spaniards learnt about the secret of cinchona in Peru, and carried it to Europe Cinchona was used by Peruvian Indians for ages as a cure for fevers of every kind

'Our home is on the street.'
A working-class district in Bombay City

A woman searching for food in the refuse in a main street in Calcutta

The story of how quinine saved the life of the Countess of Cinchona is fascinating. Medical science in this instance learnt at the hands of an Indian medicine-man. I repeat the story here, even though lately the white man's conscience has led him to challenge its authenticity.

It is in the year 1638. The Countess of Cinchona, after her arrival in Lima (Peru) is confined to bed with fever. Every alternate day, a fit of shivering seizes her, high fever consumes her, and then a cold clammy sweat drenches her. She becomes very restless. She loses all appetite for good food and is reduced to a skeleton. Her husband, the Count, is very disturbed and anxious. His physicians fail to cure the malady. He requests prayers to be chanted in the cathedral but there is no improvement in the condition of the Countess.

A devoted servant appeals to the Count to try native medicine. After consulting a friend who suffered from the same malady the previous year, the Count consents to try the medicine-man. The Indian is called in to give the medicine to kill the fever.

'Is it true that you have medicine which will destroy this demon of fever,' asks the Governor.

'Yes, it is true. We have been blessed by the Great Spirit of the Bark of the Sacred Tree Quina-Quina, and we know the art of exorcizing this demon of fire which is consuming your wife,' replies the fearless Indian. 'Our ancestors once saw sick lions, possessed by the demon of fire, tear at this bark and eat it, and get well again. When this secret of the demon of fire had been thus revealed accidentally to my tribe, the earth shook in fear at the wrath of the demon. Trees fell down, and crashed into the lake near our village. The day passed, and our people were busy rebuilding their broken huts, when they turned to the lake for water which was bitter to the tongue and coloured pink. Our Great Shaman used to send all men shaken by the demon of fire to drink the waters of this lake, and all who drank were freed from the demon. Next year this lake dried up. Then the Shaman had a dream. The Great Spirit Quina-Quina told him to tell our folk that we could always use his bark wetted in water whenever the demon worried us. The secret of the demon of fire is now our great treasure.'

The Jesuit priest now interrupts: 'His Excellency desires that you get the magic bark and the sacred water for his worthy wife.' The Indian does not readily yield.

'The men of our tribe are suffering from the "mital", toiling day and night in the bowels of the earth for the father Governor, so that

they do not see the sun for month after month. If he orders my brothers to be set free from the whip and the mines, I shall deposit the treasure of Quina-Quina at his feet.'

The Jesuit priest has a hurried consultation with the Count. The life of the Countess must be saved at any cost. The pledge given to a heathen is no pledge at all, he being outside the Christian fold. The Count is convinced. The promise is glibly given. The Indian disappears and returns late in the evening with three mud pots full of crushed bark.

The Countess of Cinchona and the Red Indian
(Fresco in Hospital de Santa Spirito, Rome)

Then begins the preparation of the medicine. A handful of the crushed bark is stirred for hours in water, and the Countess is given the first dose. 'How bitter it is!' she cries. 'He is poisoning me.' But she is cajoled into drinking it.

Next day is a fateful day; the Countess is due to get her shaking fit and fever. There is great excitement in the palace. The hour of fever arrives, and passes without harm. The Countess regains her health in a few days Twice a day the Indian prepares the medicine and feeds her with his own hands, chanting words of magic and appeasement of the Spirit Quina-Quina.

The Jesuit priest sends soldiers to collect great quantities of the bark and despatches it to Europe—in fact all over the world where

the Jesuits have penetrated. Some know it as 'Jesuits' Bark'; others call it cinchona after the Countess; still others quinine from the Spirit Quina-Quina. Treachery to the Indians of Peru gave us a valuable remedy for malaria!

The largest plantations of the cinchona tree, supplying nearly ninety per cent of the total world output, are in Java, in Ceylon and in our country. The League of Nations Health Organization has estimated that the supply of quinine was only one-seventh of the needs of the world in the years before World War II. The price of this very limited supply is dictated by a small combine of planters and manufacturers, who bolster it up by artificially curtailing production. For example, in the year 1936, the cost of producing quinine from home-grown bark in India was only Rs. 6-8 per pound. The Government of India fixed the selling price at Rs. 18, and the market eventually sold it at Rs. 22 per pound. The Kina Bureau, the international combine which controls nearly 95 per cent of quinine supplies all over the world, dictated the market rate. During the war, quinine sold in the black-market at anything between Rs. 200 and Rs. 400 per pound. Thus monopoly capitalists are minting money, while poverty-stricken, malaria-ridden millions are dying daily. The rich, in the pursuit of greater riches, are denying to their afflicted fellowmen a known remedy against malaria, even when their toll in money, and more money, is paid to them.

So world scientists have been attempting to make artificial quinine in their laboratories. As a result of research, we now have atabrine, plasmoquine and paludrine, useful substitutes for quinine. But these are still beyond the means of the ordinary toiler in our land.

During World War II malaria took a great toll, even though highly trained anti-malaria squads were attached to each fighting unit. Java and Sumatra having fallen into the hands of the Japanese, quinine was not easily available to the Allied Armies. The American Army in the Solomons and in New Guinea Islands suffered more than seventy per cent casualties due to malaria alone. The prejudice of the medical profession against the new drug, atabrine, was only dissolved in 1944. Then atabrine—the Yellow Pills—worked a miracle. In New Guinea itself the toll of malaria was reduced by ninety-five per cent. The Battles of Buna and Guadalcanal were won by atabrine-fed Australian and American soldiers, immune to the onslaughts of malaria.

Atabrine is claimed to be superior to quinine. It avoids the harmful effects which result from a daily dosage of quinine over long

periods Quinine in excessive doses causes deafness, nausea, diarrhoea, dizziness and headaches, and has been known to affect the eyesight Atabrine does not bring on any such reaction In the USA atabrine is very cheap A full course of twenty pills does not cost more than the price of an air mail stamp

But scientists refuse to rest I have just read the following in a newspaper

ARALEN MEANS NEMESIS FOR MALARIA

A drug that lay dormant in German laboratories all through the war is now going into quantity production in the USA as the most potent remedy known for the treatment of malaria

Called aralen by American chemists, the Germans did not know of its anti malarial possibilities The drug is administered in tablet form, and only two tablets are required per week as compared to the daily tablet of atabrine used by G I 's in the war

It does not discolour the skin, as do other remedies When treated with aralen, symptoms of malaria usually disappear within one day, as against the four or more days of quinine or atabrine

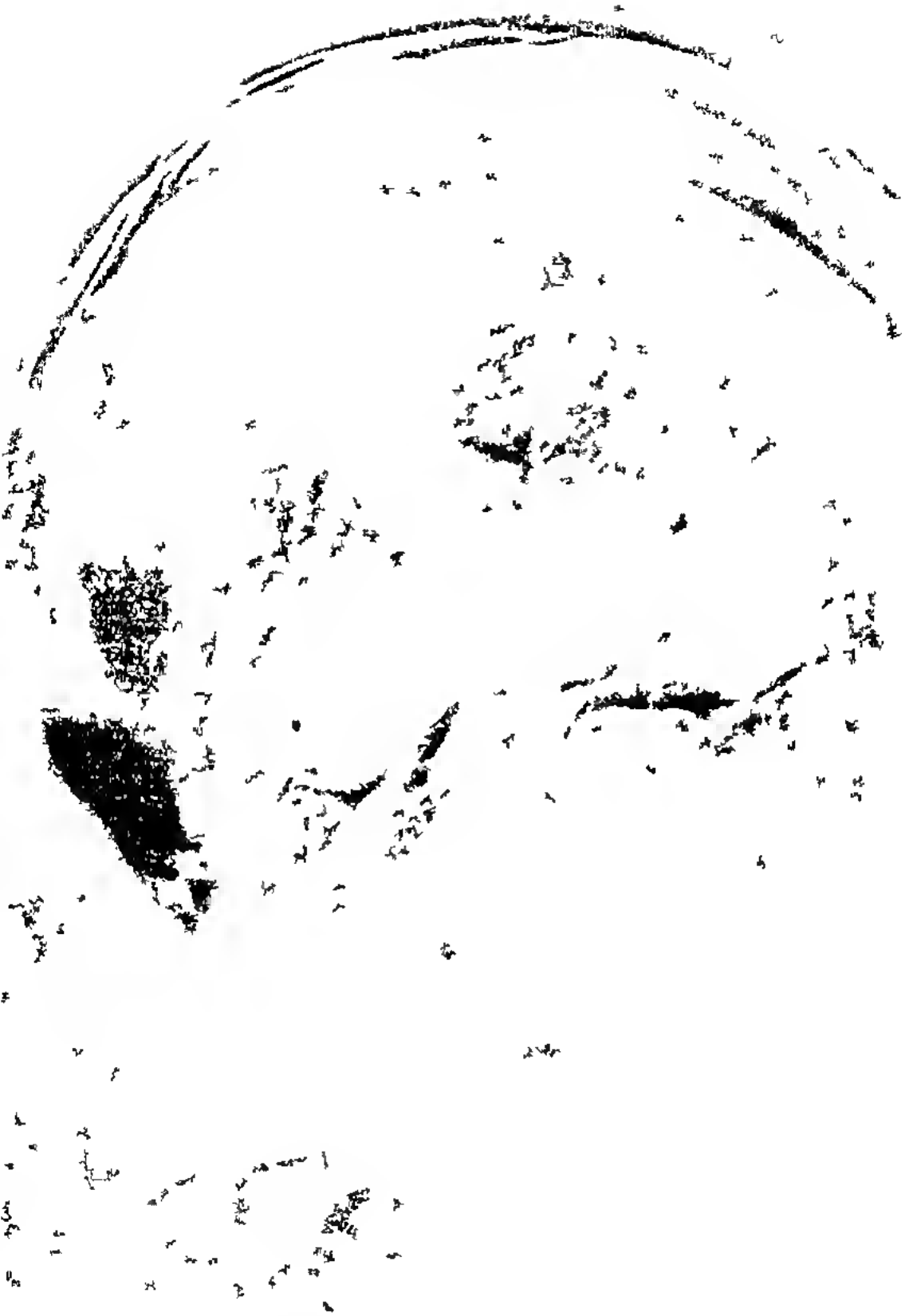
So at last the Anopheles mosquito may be neutralized It may bite and bite, but never find a malaria parasite in human blood, that would effectively wipe out malaria For this, however, it is necessary for these drugs to be made available to the last malaria patient in the wide world

Till then, how shall we stop the mosquito biting us? The observance of a few simple rules can immensely reduce the danger from this source This is our second line of defence

You have already learnt how Grassi saved his one hundred and twelve patients from malaria by keeping them indoors in screened houses, from sunset to sunrise This is a good rule However, it is possible for you to move about even at night, provided you cover your neck and feet and hands, so as not to give a female mosquito any chance of biting you

Rich people can afford to wear mosquito boots and gloves and veils Long sleeves and turned up collars also help Mosquito nets can be used to cover beds, so that the mosquito may not catch you unawares when you are asleep All these measures are impracticable in our country for the vast majority of our village folk, who go half naked because of poverty and lack of clothes

Malaria victim from a village in East Bengal



A beggar in a Lahore street His left eye is diseased and his face is covered with tumours

Another way is to apply to the exposed parts of the body a preparation of oil, such as citronella oil, bamber oil, spirits of camphor, lemon juice, vinegar, or the latest D.M.P—whose smell is repellant to the mosquito.

You must have read the following notice in our railway carriages:

PRECAUTIONS AGAINST MALARIA

All ranks are reminded that the order of dress while travelling by rail from sunset to dawn is *long trousers and sleeves rolled down*. In addition, use your Anti-Mosquito Cream.

This is how the military authorities instruct their soldiers to be on guard against malaria.

The mosquito has been closely watched and his ways of life minutely studied. We already know that every species of mosquito is not a malaria-carrier, that only certain species of the genus *Anophelis* can play the part of 'death-agents'. Scientists have found out that the number of species capable of carrying malaria is limited to about twenty-five, while the variety of mosquitoes easily touches the thousand mark.

Even then, the problem is not easily solved. It will surprise you to know that the mosquito which is harmless in the rest of Europe, is the very species which is the root cause of the evil in the Volga Valley. Some species breed in stagnant waters, others in brackish waters, and yet others in flowing rivers—and all harbour the malaria parasite in the different countries equally effectively.

The malaria problem has to be studied locally and from the beginning, when you wish to attack it in a certain locality. In one place, the breeding ground may be a marsh, as in Italy, and in another it may be valleys at the foot of mountains, as in the Himalayas. The first task of the scientist is to find out what breeding conditions are suitable to the local dangerous species of mosquitoes. The second step is to so change the surroundings that that species will be forced to abandon the locality. Thus where the death-agent breeds in water and must have a lot of shade, the shade should be removed; where the mosquito breeds in water and must have a lot of sun, thick bushes should be so planted that they offer impenetrable shade. If the species prefer stagnant water, means must be found to stir it; if in marshes, then drain them; if in clear pools of water, then contaminate them with putrefying grass. Where the malaria mosquito prefers flowing water, we must construct dams with sluices which will alter-

nate a dry bed and a rushing torrent It has been the experience of engineers that mosquitoes suddenly appear from nowhere in the world, when big road making operations or bridges are being undertaken, or when forests are being cleared When soil is turned up it is likely to provide a happy breeding ground When flood occurs, malaria follows close on its heels When there is a drought, and flowing rivers dry up into shallow pools, then too malaria combs the land The biggest malaria epidemic of recent years was in Ceylon in 1935, when the rains failed Of course the crops failed, and there was great distress Malaria attacked the weakened populace with the force of a sweeping tornado

If you go out hunting mosquitoes, in how many places will you look for them? You must know the favourite breeding grounds, the select haunts of the Anopheles The experience of mosquito hunters tells us that where there are swamps or marshes, lakes or reservoirs, ponds or tanks, dry river beds or little streamlets, whether you are in a rice field or sitting on the bank of an irrigation canal, or at the foot of a hill where water is seeping through regularly, inside wells or cisterns, in nine cases out of ten, you will hear mosquito music with the Anopheles choir

You may also meet the elegant lady mosquito nesting in hollows inside rocks or trees, in pits and depressions in the ground, in gutters and in hydrants, in the dark recesses of houses and godowns, even using your shoes and empty vessels on shelves

The campaign to wipe out the Anopheles is led by Paris green, a spray powder harmless to man and animals, but fatal to the mosquito I must tell you what happened in Brazil From 1930 to 1939 Brazil suffered from the malaria scourge, and thousands died in the death grip of the poison the Anopheles mosquito spread Then the Government of Brazil sought the aid of the Rockefeller Foundation in the U S A., and together they went into battle against this death dispenser Five hundred thousand pounds of Paris green were issued as ammunition to hundreds of trained anti malaria soldiers, and not a single pond, well or puddle escaped the withering fire When they had finished the job, the Anopheles mosquito had left Brazil, possibly for good

In the war against the larvae of mosquitoes, oil is spread on the waters This prevents the larvae from breathing, suffocating them to death Ordinary kerosene oil and crude oil mixed together make a good preparation It spreads an impenetrable oily film on the water

There are species of fish which feed on the larvae of mosquitoes

1

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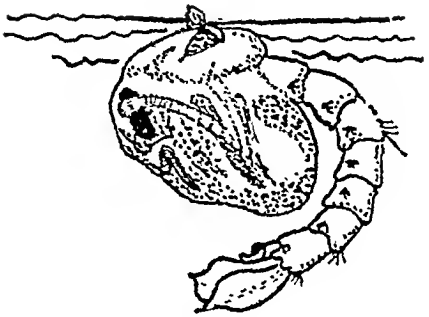

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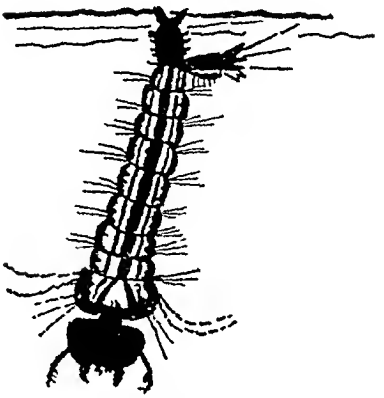

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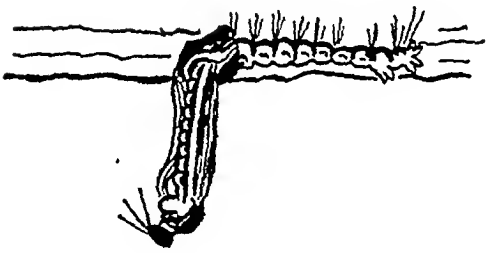

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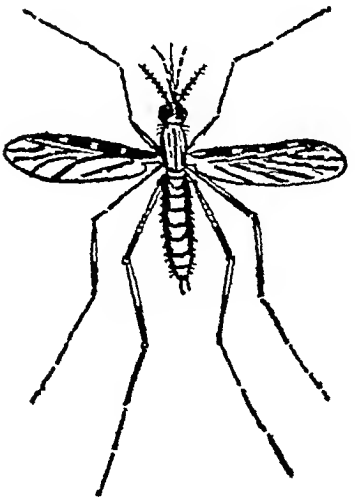


6

LIFE CYCLE OF THE MOSQUITO

1. Egg.
2. Raft of eggs.
3. Pupa.
4. Larva.
5. Mosquito coming out of larva.
6. Anopheline mosquito (*female*).

The Malaria Institute of India stocks a large number of fish known as Gambusia and Khajura. When introduced in wells and ponds, they feed on the new generation of mnsquitoes which has yet to spread its wings and fly. There are plants too which grow in water, like duck-weeds, and their only qualification is that they kill the larvae of the mosquito. Today the new secret weapons against the adult Anopheline are D.D.T. and pyrethrum sprays.

Once it finds its way into the body of the human victim the malaria parasite slowly destroys him. It enlarges the spleen, brings on congestion in the liver, the lungs, the alimentary canal, and the kidneys, starts headaches with vomiting and diarrhoea, causes fits of sneezing and ague, brings on attacks of palpitation of the heart, periodic fever and sometimes even skin troubles like urticaria. Slowly and steadily it undermines health, finally leading to a horrible death.

Science has found out sufficient cures for the fever, and has devised several methods to wipe out the guilty malaria-mosquito and its larvae. It is now possible for the whole world to be free from malaria. It is also possible for our own country to be rid of this 'man-eating' malaria microbe.

Only the will to victory is needed.

Let me hope that in your life time, the state and the people will have sufficiently awakened to their duty, and made the country safe from malaria.

Yours affectionately,
MASHI

LETTER VII

THE EYE OF SCIENCE: THE MICROSCOPE

Lina and Vijay,

You are now well-posted about malaria. Do you realize that without the microscope, the malaria microbe could never have been discovered? I am sure you would like to know how the Eye of Science—the microscope—came to be invented.

Leeuwenhoek can be said to be the father of bacteriology. His life will interest you. Leeuwenhoek is the son of a family of basket-makers and brewers. He is born in the year 1632 in Holland on the banks of the Delft. Instead of becoming a government official, as his mother desired, he becomes an expert lens-grinder. By profession he is a draper, surveyor, wine-gauger and chamberlain to the Sheriff. But his heart is wedded to work on lenses. He frequents the haunts of spectacle-makers, and begs them to teach him their art. This hobby brings him nothing but ridicule from all around him. In spite of this ridicule, he perseveres. While perfecting this knowledge, he soon makes a great discovery. Through his lenses, he sees a new world. In this world, diseases will be scientifically fought because their causes can be seen and studied.

Leeuwenhoek

Whenever Anthony makes a lens, he looks at all kinds of things through it. He puts the lens on his hands and sees how the scales of his skin form a pattern which he knew nothing about. He goes to a butcher's shop, buys an ox-eye, and examines it with his lens. He is thunderstruck at the intricate beauty of the eye. He next looks at the hair of a sheep, of an elk and of a beaver. He declares that what appears fine and smooth to the human eye is really similar to hard blocks of wood! He catches a fly, and dissects it. He separates the brain of the fly and examines the astounding details of its make-up. There is nothing sacred for him and his lens,

Everything gets under it for examination As if touched by the magician's wand, the object is transformed into the most unexpected fantastic shape

While Leeuwenhoek is struggling with his lenses, in England a new school of thought called the 'Invisible College' is started It consists of men of science who refuse to accept anything palmed off as knowledge unless it is proved These men believe in experiments One of their members is Robert Boyle, founder of the science of chemistry Another is Isaac Newton, discoverer of the Law of Gravity When Charles II comes to the throne, this insignificant society gains high status and is known as the Royal Society of England Amongst the members of this society, there is one Regnier de Graaf, who has contributed interesting information on things he has found in the human ovary

Leeuwenhoek corresponds with the members of this society and informs them about what he has seen through his lens Graaf is the only member who does not jeer at Leeuwenhoek's discoveries He encourages Leeuwenhoek to write them his observations Beginning in 1673, Leeuwenhoek writes some two hundred letters in colloquial Dutch

Regnier de Graaf

Latin is the lingua franca of the scientists But Leeuwenhoek is ignorant of Latin

The greatest day in the life of Leeuwenhoek is when he examines *a fresh drop of rain water* under his lens What does he expect to find there but water ? No, he is not the man to be satisfied with the obvious He goes to the garden, and collects water from an earthen pot He places drops of water under his lens and dances with joy at his discovery His little daughter Maria rushes into the room on hearing him shout for her 'Maria! Maria! Come here! Hurry up, Maria! I have discovered a new world ! Look, look through the lens at that drop of water I picked up from the rain gauge Do you see those tiny wretched beasties swimming around running after one another, playing hide and seek—such gambols!'

Yes, it is actually true. With the naked eye, the drop of water looks crystal and pure. But under the lens, a new world of little creatures comes into existence.

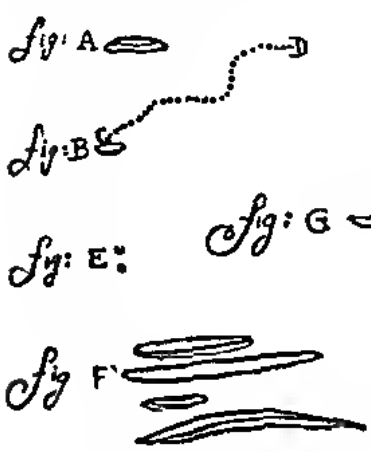
Day after day, Leeuwenhoek looks at drops of water, and collects a million observations. These creatures—the unseen foes of mankind—live and breed, multiply and die. They kill millions stealthily. They creep into the bodies of men, women, and children, through the water people drink, and in a million ways through food. Now Leeuwenhoek finds them, but he does not know their power—that they are the silent invisible murderers of tens of thousands of human beings.

The first question that strikes Leeuwenhoek is: How did these creatures get into the drop of water? Did they come from the skies with the rain, or did they crawl into the rain-gauge from the garden? Leeuwenhoek is a God-fearing man, and believes that God created the world. Yet, somehow he feels that these creatures cannot have been born of nothing. They must have parents. 'I shall experiment and find out.' He takes water from the eaves-trough. This water too has the 'beasties'. He is not satisfied. He brings a porcelain dish, glazed blue, from the house, props it up on a table in the garden, and waits for the rain. The first collection of water he throws away, so that there may be no chance of anything already in the pot getting into the water. Then he examines the new collection of water. 'I have proved it! The beasties do not come from the sky. There is not a single one of them in fresh rain water.' For four days, hour after hour, he goes on examining the water. Only on the fourth day he discovers the beasties again. Where did they come from now? Leeuwenhoek does not know. But they certainly did not come from the sky with the rain water. Of that he is certain.

Leeuwenhoek pursues these microbes—'wriggling sticks'—everywhere. His lens spots them in millions on the smallest grain of pepper. He scratches his clever head till he evolves a system by which he measures them. He declares: 'One drop of my pepper water contains more than two million seven hundred thousand of these beasties—more than the population of the whole of Holland!'

At last the Royal Society proclaims him their honoured Fellow, the greatest distinction they can confer on him. Leeuwenhoek does not rest on his laurels. He is a hard-working, honest scientist. Praise cannot turn his head. He keeps on studying with his lens, gazing and searching till his eyes ache.

Leeuwenhoek is an indefatigable observer. One day his attention is caught by the white stuff that remains between his teeth even after he had cleaned and rubbed them hard with a piece of cloth. 'Aha! I must look at you with my lens. I must know if you are just dead matter or....or....Well, let me see first,' he says. He locks himself up in his room, scrapes the white stuff from his teeth and focusses it under the lens—his very best lens.



Drawings of bacteria from Leeuwenhoek's Letter No. 39

'What is this? It is full of the beasties! This one has the shape of a fish. Look at the way it leaps about! Now this is another kind—this one is like the clown in the circus—it advances, whirls round—and then somersaults on somersaults! And what are these bent sticks? They are all alive! They remind me of a procession—the stately, slow-moving majestic Bishop in front, and then the riff-raff mob, bent and lame, men of all sizes and shapes, and then the acrobats spinning like corkscrews. Imagine the zoo that lives in my mouth! Auf! I feel sick at the very thought of it,' he cries aloud.

Now Leeuwenhoek has only one obsession—to repeat his experiment over and over again, to look at the stuff from inside the mouths of all and sundry he meets. On a lovely day in September 1683, Leeuwenhoek sits down to write to the Royal Society his Letter No. 39. It is a famous letter, and let us peep into it.

'The second sort had the shape of Fig. B. These oft-times spun round like a top, and every now and then took a course like that shown between C and D; these were far more in number.

'To the third sort I could assign no figure; at times they seemed to be oblong, while anon they looked perfectly round. These were so small that I could see them no bigger than Fig. E; yet they went ahead so nimbly and hovered so together that you might imagine them to be a big swarm of gnats or flies.

'For my part, I judge for myself, that all the people living in our United Netherlands are not as many as the living animals that I carry in my mouth this very day.'

He finds that when he drinks hot coffee, the beasties disappear, and such as remain are listless and dying. Even vinegar has the

same action. But lack of air does not matter to most of them. He finds a new 'beastie' which slides along, gracefully bending its body in rhythmic motion, even as the snake does. He finds the beasties in drinking water, in the intestines of frogs and horses, and in his own discharges, when he is suffering from 'looseness'. Leeuwenhoek is satisfied by merely looking at them. It does not strike him that these beasties may be connected with diseases. With stoical indifference to the consequences of his observations, he records how his wonder grows from day to day as he looks at them with better and better lenses, over whose preparation he spends days and weeks. By this time Leeuwenhoek possesses hundreds of these lenses, but he refuses to part with a single one of them. He is a miser where his lenses are concerned, and it is the same with his knowledge of lens-grinding.

He is the first to observe the blood vessels inside the tail of a fish, and see blood pass on to the veins from the arteries. He discovers the human sperm, the seed from which human beings are born. His fame begins to spread everywhere. Great men and women of those days visit him, travelling hundreds of miles in order to have the chance of peering through his gold-mounted lenses.

Leeuwenhoek is not affected by this publicity and fame. He writes to the Royal Society: 'My work, which I have done for many a long year, was not pursued in order to gain the praise I now enjoy, but chiefly from a craving after knowledge, which I notice resides in me more than in most other men. Most men are not curious to know, nay, some even make no bones about saying: what does it matter whether we know this or not?'

He keeps on looking through his lenses and blowing up one medical superstition after another. But he is no prig; he is broad-minded, open to conviction, and ready to acknowledge his mistakes. He goes further. As a scientist he realizes that nothing is final. His God is Truth, and in search of truth he is willing to confess that he has often stumbled. 'My determination is not to remain stubbornly with my ideas, but I will leave them and go over to new ones as soon as I am shown good reasons which I can grasp. I have no other purpose than to place truth before my eyes so far as it is in my power to embrace it. I shall use the little talent I have received to draw the world away from its old heathenish superstitions, and to go over to the truth and stick to it.'

Leeuwenhoek has minutely described protozoa and bacteria, though he calls both of them animalcules. Everything that moves

has life in it, that is his conclusion. He records : 'The little animal was incredibly small, so small in my sight that I judged that even if hundreds of these very wee animals lay stretched out one against another, they could not reach to the length of a grain of coarse sand; and if this be true, then ten hundred thousand of these living creatures could scarce equal the hulk of a coarse sand-grain...I must say for my part that no more pleasant sight has ever yet come before my eye than these many thousands of living creatures, seen all alive in a little drop of water, moving among one another, each several creature having its own proper motion.'

This is the first of the microbe-hunters. He is a hunter who delights in the chase. He is the first to locate the fox-hole where nobody suspects the fox hiding. He is so wonder-struck at his own discovery that he forgets all about hunting and that the fox may be an enemy of peace-loving mankind. He finds microbes where nobody has seen them before. But his work ends here. He gives science its eye.

Leeuwenhoek dies in the year 1723, at the age of ninety. For a long number of years there is no scientist of equal eminence to take his place—till Spallanzani arrives on the scene.

Yours affectionately,
Mashi

'This is the reward for our labour' Working-class slums in Deolali

Yes we live here A Calcutta railway worker s home near Sealdah Station

LINA AND VIJAY,

Leeuwenhoek was as industrious as an ant in search of food before the monsoon. He struggled with his microscopes endlessly, indefatigably.

He was a good workman, and good workmen never quarrel with their tools. The apparatus available to him was not of the perfect kind which is obtainable in the market today. His Eye of Science was only a magnifying lens. He was never satisfied with the best lens he ground ; he was always trying to better his best.

In grinding lenses, Leeuwenhoek was following the profession of his people. The Dutch had been grinders of glass and diamonds for generations. Long before Leeuwenhoek was born, in the sixteenth century, Janssen had already devised the 'flea-glass'. These were lenses specially made, so that old people whose eyesight was failing, could see better.

The story of the 'flea-glass' is entertaining.

The Dutch housewife is a meticulously clean person and very proud of her spotless house and speckless kitchen. One day, Frau Janssen, the wife of Hans Janssen, the spectacle-maker, enters her kitchen to find her husband and son, armed with thin needles, on their hands and knees, searching the cracks in the wooden boards of her kitchen floor. Frau Janssen's pride is hurt, and she shouts at her husband: 'Hans Janssen, get out of my kitchen. You ought to be ashamed of yourself, leading your son into this disreputable business of casting a slur on his mother's reputation ! There are no fleas in my kitchen. I tell you, there are no fleas. I clean it everyday.'

Frau Janssen is very annoyed, and reaches for the broom to frighten them away, because they refuse to listen to her remonstrances.

But her son Zachariah comes running to her and says, 'Look, mother dear, I have caught a flea'. And he holds up the needle which has a small black speck on its point.

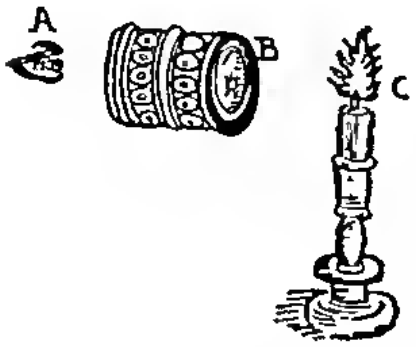
'Get out, I tell you. I am very angry with you. This is no way to joke with your elders', cries the mother, pushing him away.

'But the boy is telling the truth, little mother,' says Hans.

And together, one after another, they look at that speck through a thick glass which has been mounted in metal.

Frau Janssen cannot believe her eyes. The flea which looks like

nothing more than a small mole with the naked eyes, appears hideous and formidable seen through the 'flea-glass'. It has thin long hair all over its body, a bloated stomach like a frog, and legs which move up and down ever so frantically. It is an ugly, ferocious animal.



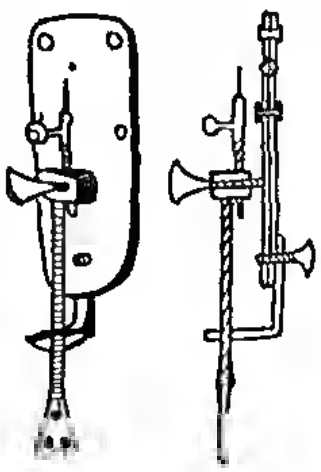
Janssen's 'flea-glass'

Frau Janssen drops the 'flea-glass', brings pails of water and scrubs her floors for the rest of the day, scrupulously removing the tiniest black spots She keeps a 'flea-glass' in the pocket of her skirt ever after.

Hans Janssen and his son now specialize in making glasses which are perfectly useless for ordinary purposes of reading or sewing. The Janssen 'flea-glass' magnifies the image ten times the size of the original.

In 1632, Leeuwenhoek is born; in 1635, Robert Hooke is born; and in 1637 Jan Swammerdam. All three improve the 'flea-glass', and now it can magnify about two to three hundred times the original.

If the Museum in Munich has not been bombed out of existence in World War II, you can still look through the 'flea-glass' of Janssen, the rough and ready simple contraption mounted with gold and silver frames which Leeuwenhoek used, the apparatus made by Hooke, the binocular-microscope of Cherubin d'Orleans, the first mirror that Hertel introduced, the tube with the two convex lenses at a fixed distance which the scientists named Wollasten Doublet, and all the subsequent improvements which followed one by one till the final modern high-power compound microscope is reached.



Leeuwenhoek's microscope

How is it possible for Leeuwenhoek and his companions to record all they did with such crude instruments?

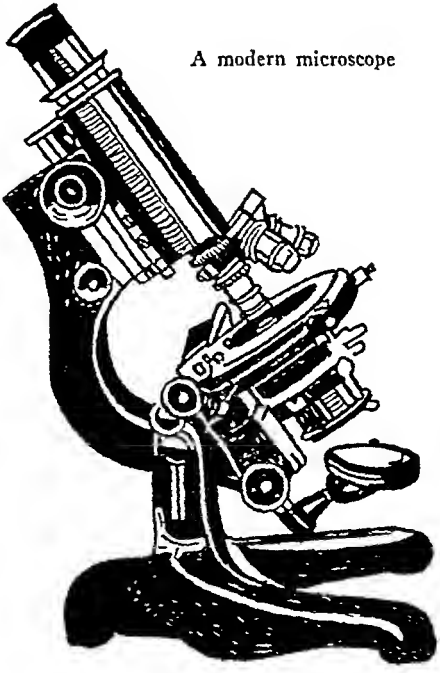
I am quite sure that you will not be able to spot half the things that Leeuwenhoek, the 'Wizard of the Lens,' located. What is the secret of his success? Leeuwenhoek has infinite patience. He spends hours and days looking at a single drop of water, even when he cannot see anything new. He has the perseverance of the spider, mending a broken thread in its web. He has faith, unbounded faith, in being able to find something new, if he can only make a finer lens. He toils like a giant, building a huge palace, single-handed. He perspires, his eyes water, his neck and back ache, he cuts his fingers with broken glass and burns himself repeatedly when his hands shake from old age, over-work and fatigue. But Leeuwenhoek is not to be deviated from the one all-absorbing purpose of his life : uncovering the mysteries of the world of microbes. He is not a very clever man, but he has the dogged perseverance of a genius. After all, genius is only a capacity to take infinite pains over the minutest details. By that standard, Leeuwenhoek is a greater man than all the kings and generals and statesmen of his age.

Compared with the modern microscope, the microscopes of those early days are mere toys with which these pioneers of bacterial science play about looking inquisitively at everything.

From Leeuwenhoek, the scientific world learns to look inside drops of water, the scrapings from one's teeth, inside the tail of a fish, and also finds 'animalcules' inside the human sperm.

From Swammerdam comes the first knowledge that our blood has red blood-cells as separate from the serum liquid in which they float.

From Malpighi, modern anatomy derives its basic ideas. The lungs are not one solid mass of flesh, but are spongy, and have small pockets in which the air from the windpipe can lodge, in which the blood enters black and comes out red and purified. He also shows how the kidneys are not a superfluous organ, as Aristotle thought, but essential for throwing out waste matter from the body. Malpighi with his microscope enters the 'maze of fairyland' which is our



A modern microscope

human body, and exposes one fallacy after another in which medical science has been bogged.

From Kircher, the Jesuit priest who was a musician, physicist, mathematician, optician, physician and archaeologist, all rolled into one, comes the news that his microscope has spotted germs inside the blood of a plague victim.

Marcello Malpighi

These men with their microscopes not only dare to enter the thick jungle of ignorance and superstition, but also cut out paths, and occasionally put up sign-boards to guide future generations of scientists. And the sign-boards are mostly correct.

Today the modern microscope is an elaborate instrument for magnifying an object a thousand times its original size. It has a hollow platform on which the object to be examined can be rested.. Above this platform is a long tube with lenses at either end. Both are magnifying lenses so adjusted that the enlarged image cast by the lower lens is picked up and magnified by the eye-piece. There is scope for focussing the object so that it can appear clear-cut and sharp. Below the platform there is a small adjustable mirror, which reflects light into the condenser, which is further governed by a diaphragm. The object is thus lighted up from beneath.

Other gadgets can be added. A triple nose-piece, with three lenses of different power, higher than the original ' objective lens ', can be attached to the lower end of the tube, thus permitting a deeper sight when smaller microbes have to be spotted.

There is also available an ' oil-immersion lens ' which is used with a drop of cedar-wood oil. The lower lens is immersed in the oil and fixed to the objective. The oil prevents light rays escaping, and allows very high-power observation to be done.

And now we have the electron-microscope to spot even filterable virus.

The microscope is no longer the interesting toy of the electron-

optician, but a potent weapon in the hands of the research-worker in the field of microbiology.

We have today an institute on the Delft in Holland, devoted to the electron-microscope, as also an Electron-Microscope Society in the U. S. A. In September 1946, a conference of experts met at Cambridge in England, to exchange notes on the electron-microscope—the first of its kind in the British Empire.

The image formed in an electron-microscope depends for its contrast on the unequal scattering of electrons by different parts of the specimen exposed in front of it. But the machine has now become complex, and the user of this latest microscope must be a clever physicist who knows the principles of the design that go to make it up. Otherwise, he has pit-falls waiting for him at the first turn of the first lever he manipulates.

Today, the theoretical limits of magnification have been extended to two hundred thousand times the original specimen. If you remember that Janssen's flea-glass magnified ten times, you will realize the advance modern science has made.

The microscope opened the first gate that led to microbe-land. The microscope stands first as a weapon in the armoury of microbe-hunters, and it may well prove to be the last to put a seal of finality on their achievements in the future.

Yours affectionately,
MASHI

LETTER IX

LINA AND VIJAY,

In 1729, exactly six years after Leeuwenhoek has stopped looking through his lenses, Spallanzani is born in a lawyer's household in North Italy. His home-town is separated from the land of Leeuwenhoek by over a thousand miles. This son of Italy is the heir-apparent to the crown of microbe-hunters whose glory the Dutchman bore so ably during his life-time.

When he is young, Spallanzani is a problem-child. He does not care to play with other children of his age, nor is he interested in the usual toys which delight the others. He prefers to trap flies, gather worms, pick out bugs, and rope in beetles—all for the pleasure of finding out how they work. He pulls off their wings and legs, and then tries to stick them on again. He cuts them up and wonders how they can be restored to life once more. He is always trying to find out how living things work.

In the woods of Northern Italy, he comes across natural fountains. He asks his father about them. 'They spring from the tears of deserted damsels lost in the wood,' is the answer. Spallanzani is unconvinced. He has an aversion to superstition, even at that early age.

At the University of Reggio he studies mathematics and the ancient poets. But the mad passion of Leeuwenhoek soon grips him. The one question that is creating the greatest discussion in the learned world is: Is it possible for living things to be born without parents—to arise spontaneously? The weight of public opinion leans towards the view that mice, beetles and wasps arise from mud or cow-dung.

Spallanzani is one of the rebels. He refuses to accept the prevailing theory that insects have no parents. At this time Spallanzani comes across a small book by a man called Redi, an unknown investigator. Redi writes about a simple experiment he carried out in his laboratory.

Redi cleaned two glass jars, and put small pieces of raw meat in each one of them. One jar he covered with a thin net in order to prevent flies from getting at the meat; the other jar he left open. Redi now kept close vigil on the meat in both the jars. He soon spotted flies getting inside the open jar, playing hide-and-seek round the meat, then flying away. In course of time maggots appeared, and a little later, new flies were born. In the other jar there were neither flies nor maggots.

This experiment inspires Spallanzani to concentrate on the 'beasties' of Leeuwenhoek. He buys a microscope and fumblingly learns how to use it perfectly. He is so taken with the world of microbes that all things on which he can lay his hands go under the lens. All day he looks at them, and then he dreams about them at night.

Spallanzani

At this time, the world is stirred by a priest by the name of Needham. Needham claims to have proved that microbes have no parents. Here is his argument—he boiled mutton gravy in hot ashes in order to kill all possible microbes that might be living in the gravy; he corked the bottles and put them away safely on a shelf. Some days later, he put drops of this gravy under the lens, and found millions of microbes fighting with one another for space. Where had the microbes come from? They had certainly arisen in the gravy by themselves spontaneously.

Needham has taken the whole scientific world by storm.

Spallanzani however shakes his head in disagreement. He rushes to his laboratory to repeat the experiment and test the truth for himself. He prepares a whole set of gravy bottles and corks them as Needham has done. Then the imp in him prompts, 'Why not shut your gravy bottles with glass so that the gravy may be hermetically sealed?' So Spallanzani has two sets of bottles, one corked and the other with the necks of the bottles melted and closed. Some days later, he opens both the sets, and swings his microscope into focus to look at their contents. To his great glee, he finds that his second set of bottles, sealed with glass, has not a single microbe. The corked ones are over-flowing with microbes. Now Spallanzani writes a paper, a most sarcastic paper, and tells Needham that when a scientist corks a bottle, he takes good care to see that no air gets through.

However, Spallanzani is not to be appeased by a slight victory over Needham. He follows this experiment with another one. He

uses glass-sealed bottles of gravy, but boils them for different periods. He is himself surprised at the result. He finds that the bottles boiled for a few minutes still contain a small number of microbes though weak, sluggish, and half-dead. The bottle that he has boiled for an hour has no microbes at all, even when he keeps it on his shelf for a whole month before he opens it to examine its contents.

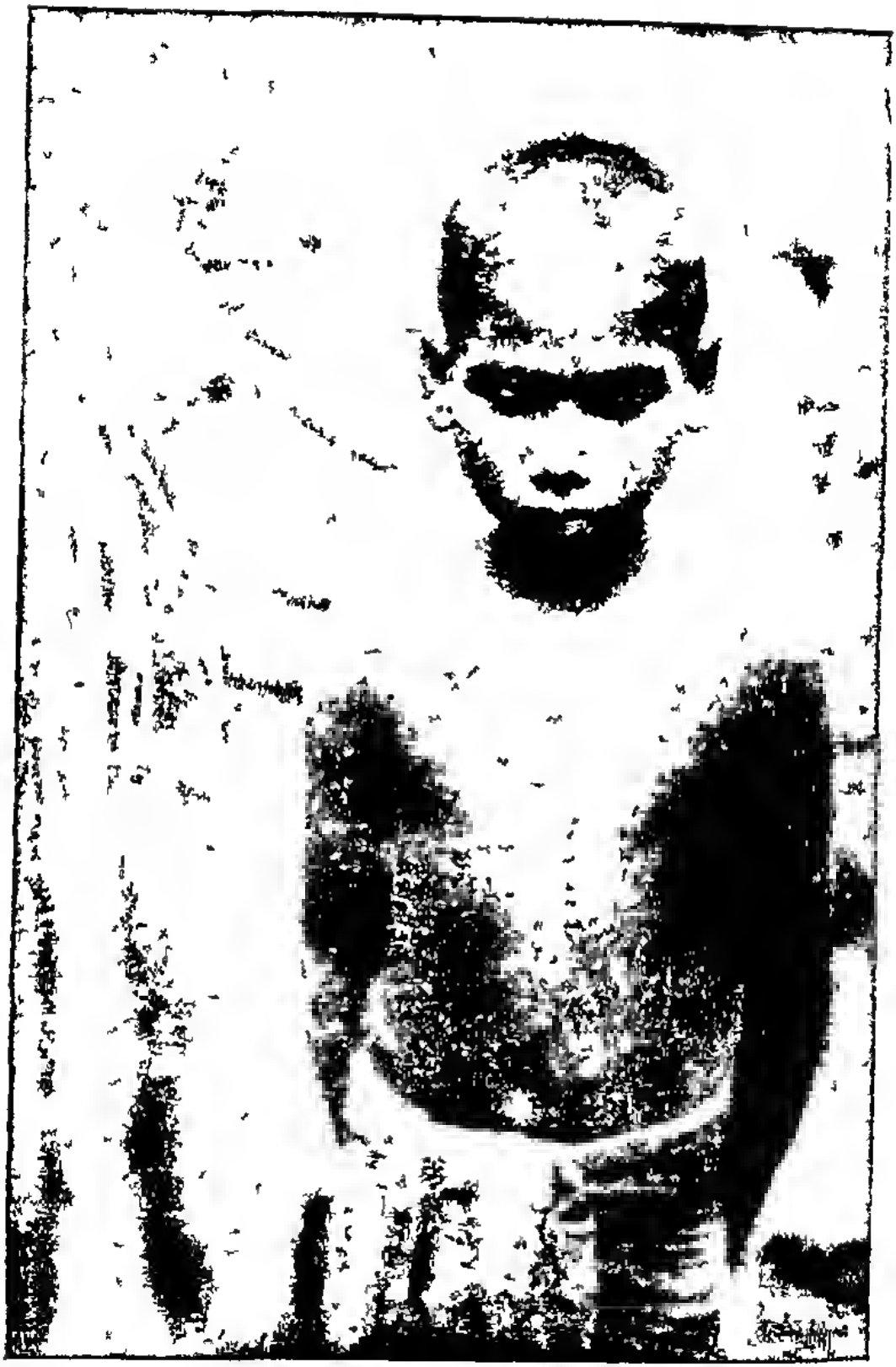
Now is Spallanzani's turn to surprise the scientific world. Not only has he proved Needham wrong, but he has also established the fact that some microbes can survive heat up to a certain point; and yet when the heat becomes excessive, no microbe can live through it. The gravy is not likely to go bad, however long you keep it, provided you do not use cork but seal the bottles with glass. That experiment of Spallanzani has made it possible for us to have tinned foods sent to us from far off America and Australia. Spallanzani thumps his table and shouts to the scientific world: 'Everything in nature follows the same law of birth and death. Even microbes have parents, though a million would occupy less space than a single pinhead.'

Needham is not so easily outdone. He argues back, 'Signor Spallanzani, you think you are very clever indeed. I assure you, you have proved nothing at all. When you boil the gravy too long, you not only kill all the microbes, but also "vegetative force". It is this vegetative force which gives birth to microbes. It is this vegetative force by which Eve grew out of Adam's rib. Once again it is this vegetative force which gives rise to the reputed worm-tree in China, which is merely a worm in winter and is transformed by this vegetative force into a tree in summer.'

Spallanzani accepts the challenge. He cleans up his laboratory table for fresh experiments. He washes his flasks and fills them with soup. Then he separates the flasks. The first three he labels A,B,C, and boils them for a few minutes only; the second lot D,E,F, a little longer ; and the third lot X,Y,Z, for over an hour. He corks his bottles, as required by Needham.

For the next few days he is the most impatient man on earth. Then he brings down his microscope, and looks at the contents of the different bottles. 'There you are! Whether you boil it for one minute or one hour, that hardly makes a difference, Mr Needham. Every one of these bottles A to F and X to Z have millions of microbes in them. Your theory of vegetative force is absurd. There is nothing like it in nature. It is the air that gets in through the

Bright and cheerful, a Delhi working-class girl, blind from birth, for her parents are diseased



A boy with smallpox, in a village
in Pariyaram, Cochin State

cork, which carries mother and father microbes, that breed in the gravy and multiply.'

In order to blow up the myth of this vegetative force, he repeats the experiment with soup made of seeds which are burnt to such an extent that they have practically become charcoal. And yet the soup of these charred seeds, when kept for a number of days in corked bottles, produces millions of microbes. Needham is completely exposed.

Spallanzani becomes the triumphant hero of science, with whom now Frederick the Great of Prussia personally corresponds. He is appointed a member of the Berlin Academy. Maria Theresa, Empress of Austria, appoints him Professor of Natural History at the ancient University of Padua in Lombardy.

Spallanzani is a tireless worker. He continues with his experiments. He observes microbes in vacuum and records, 'These animalcules are astonishing! They are able to exercise in a vacuum the functions they perform in free air. They go up and down, and multiply for several days in this vacuum. This is really wonderful when one considers how we have always believed that there is no living being that can live without the advantages air offers.'

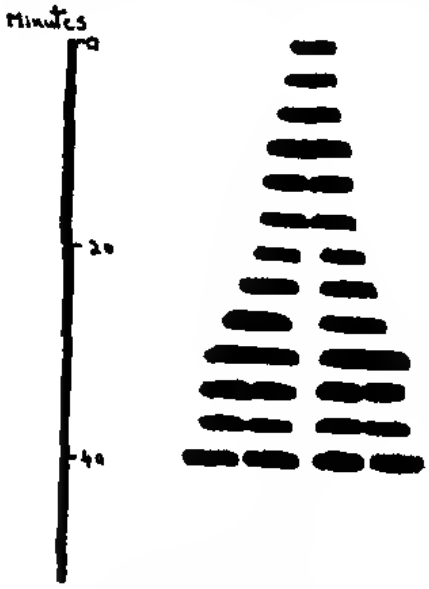
He is constantly playing tricks with microbes. He blows tobacco-smoke at them, and finds that they disperse as soon as the irritating smoke touches them. He observes that electricity kills them immediately.

Then he turns to his last great experiment. This time he exposes an English scientist named Ellis, who maintains that microbes are born to mother microbes, just as human mothers give birth to children. Ellis has written, 'When I look carefully with my microscope, I can actually see young ones inside the old ones, and looking still more closely—you may not believe it, I can see grandchildren inside these young ones'.

Spallanzani watches the microbes with his microscope incessantly day and night. He wants to separate one microbe and watch it give birth to younger microbes. But a microbe is so tiny and small, it is invisible to our natural eyes. It is only with the eye of science—the microscope—that you can see it. Then how is he to separate this one-twenty-five-thousandth of an inch long creature? But Spallanzani is a resourceful man. Where there is a will there is a way. He finds a method of overcoming this difficulty. He puts a drop of seed soup full of microbes on a glass-slide and near this puts another drop, this time of water which is free from microbes. Then

he takes a clean needle and makes a thin connecting canal between the two drops on the slide. He focusses his microscope lens on this canal, and just as the first microbe sails down the canal and reaches the fresh-water drop, he cuts off the canal with a tiny camel's-hair brush.

'God Almighty! I have done it,' he shouts. 'No human being has ever succeeded in possessing a drop of water in which there is only one microbe! Now the hypothesis of Ellis that small microbes are the resultants of an accidental clash between two big ones is not applicable. There are no two microbes here.'



The microbe multiplies

The eye of Spallanzani is glued to the microscope. He refuses to be dislodged from his observation post. At last he sees a strange sight.

That thin rod of microbe begins to get thinner and thinner in the middle—so thin that the thread of a spider can be considered thick. As Spallanzani is wondering what will happen next, the two ends struggle frantically and pull themselves apart. Now there are two microbes instead of one. Spallanzani watches each microbe grow to the size of its parent and then split into two. Thus the population of microbes multiplies into hundreds and thousands in that single drop of fresh water.

Spallanzani is a scientist, and a scientist never broadcasts a discovery after one successful experiment. So he repeats his observations over and over again. Then he begins to write. And what a hurricane he lets loose. He extinguishes the name of Ellis from the list of microbe-hunters. Ellis used the microscope, but it is a case of eyes that see not. He leads science into a labyrinth, because he is hasty in announcing theories based on insufficient and incorrect facts.

Spallanzani has run his race. His bladder is diseased. Even in the last moments when death stares him in the face, he is true to science. He orders, 'When I am dead, immediately cut me open, and remove my bladder, and send it to the doctors and scientists for examination. Let them learn from it what a diseased bladder looks like, and possibly find out a cure for future generations. It will be too late for

me. That does not matter.' If you visit Pavia in Italy, you will see not only a bust of Spallanzani, but also his bladder preserved in the museum.

So ends the eventful and inspiring life of Spallanzani. He leaves behind him the immortal spirit of the science of microbe-hunting more glorious than he received it from Leeuwenhoek.

Yours affectionately,
MASHI

LETTER X

THE CURSE OF GOD: ANTHRAX

LINA AND VIJAY,

After Spallanzani writes his name in letters of gold in the pages of history, many microbe-hunters, mostly pseudo-hunters, try to monopolize the world of science. Many fantastic claims are made. It becomes the fashion to peer down the microscope, announce startling observations and claim immortal fame. The microscope is the new toy with which the armchair intellectual of the day regales himself. The science of microbe-hunting is only saved from the meshes of these fraudulent discoveries when Louis Pasteur and Robert Koch come forward and throw new light on microbes.

Robert Koch is the first eminent scientist who succeeds in spotting the bacillus of tuberculosis and in isolating it. Before he can focus his lens on this elusive bacillus, he performs hundreds of interesting experiments. He trudges a long and weary road of hard work, daily toil, burning midnight oil and sacrificing all his leisure for the sake of the self-imposed task of finding the cause of disease.

Robert Koch

Listen to the story of the romantic, single-minded Robert Koch.

Koch is born in 1842 in Germany and graduates as a doctor from the University of Gottingen. His one youthful passion is to roam over the world, see new places and meet new people. Adventure and a free life of the hobo attract him. How can he realize this dream? 'I shall become a ship's doctor, float over the seven seas, and gaze with my own eyes at the seven wonders of the world,' he says to himself. But this dream is not to materialize so soon.

In the year 1866, he becomes a doctor in a lunatic asylum in Hamburg. Confined to the four walls of this living inferno, distracted by the shouts of half-idiots and the wails of maniacs, it is not surprising that the amazing discoveries of Pasteur never reach his ears. At this time he meets Emmy Fraatz, and between them begins a long courtship. He ultimately musters sufficient courage to propose to her. He glibly talks about a life of romance and adventure in the wilds of the East.

Emmy is a sober, matter-of-fact girl who wants to set up a home and live comfortably. Robert and Emmy are married, but not till Koch gives up all ideas about visiting romantic islands, hunting in frightening jungles and breathing the sea air on enticing expanses of wide oceans.

Koch settles down as a practising doctor in the prosaic villages of Prussia. He drudges wearily through this dull routine life, daily attending to the sick and prescribing medicine which he is not certain will cure them. He wants to find out how disease gets into man, and slowly yet surely destroys him. Koch is furious with the medical profession because the blind cures it prescribes are mostly superstitious quackery.

In his twenty-eighth year, he moves to Wallstein, a small village in East Prussia. He is a very disgusted and tired Koch. In an attempt to divert his mind from his 'stupid practice' and brighten up his life, his wife buys him a microscope. 'He is always looking at everything through his old magnifying lens. I am afraid he will hurt his eyes. The microscope may satisfy his curiosity, and then he may have more time to spare for me,' so thinks Frau Koch.

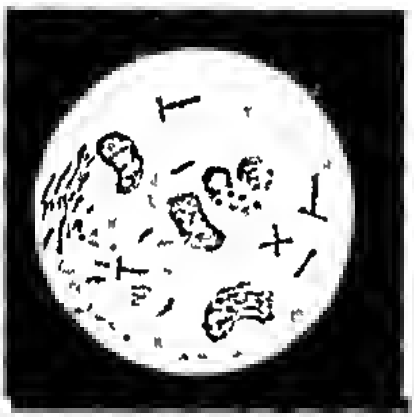
Koch takes to the microscope as a fish takes to water. He and the microscope are not to be parted for the rest of his life: the two become lovers who are inseparable. Koch finds a new world through the eye of the microscope, a world which is fascinating beyond his wildest expectations. More and more as the charm of the microscope increasingly captivates Koch, poor Emmy is forgotten, as also food and clothes and comforts. Dead bodies of cattle and sheep become more attractive to him than his wife or ailing patients. Koch begins to study the weird doings in the microbe world. There is nobody to teach him. He has to depend upon his own wits, and the very reliable eye of the microscope. He even has to teach himself how to use it perfectly. Indefatigably, Koch examines everything. He cannot rest by night nor stop thinking about the microbe world during the day.

Meanwhile, ignorance about epidemics is universal. For instance, in Europe, western civilization cannot stop exasperated peasants, victims of disease, venting their wrath on old women suspected of witchcraft. They yoke them to the plough and beat them to death in an attempt to fight off the 'evil eye'. Pasteur in Paris preaches that microbes must be the hidden murderers of men ; there is nobody to take him seriously. Koch in a lonely corner of Germany, is unknown and unsung. He fumbles with his glass-slides and his micros-

cope behind the partition he erects inside the consulting room, where he receives his distracted patients. And just as Pasteur knows nothing about Koch, Koch is ignorant of the existence of Pasteur.

The scared farmer-patients bring Koch stories about the 'curse of God' that visits their flocks of sheep and cattle. Suddenly, all too suddenly, a healthy lamb full of the unbounded joy of life falls ill and lies down, morose and ailing. By the time the sun rises on another day, the little life is extinguished, the soft fluffy snow-white lamb is stiff and cold, its blood has turned black—a ghastly black! And this is only the first blow. Swifter and swifter come more blows. Not one lamb here, not another there, but sheep and cattle too die in hundreds. A farmer, who feels safe and prosperous, is punished overnight more gruesomely than if the worst marauding army had visited him. Sometimes the farmer himself catches the disease. Boils erupt on his body, and then fever swiftly does the rest. He too dies—with his blood the colour of the mourning gown that his widow puts on to accompany his bier to the grave.

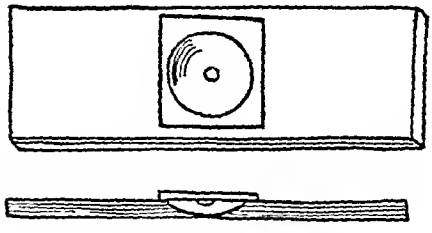
Koch swears a great oath under his breath, clenches his teeth, drags out his microscope and glass-slides and focusses his attention on drops of blood from the cattle killed by the disease. Slide follows slide in endless succession. The same phenomenon faces him day and night. His wondering eyes behold among the tiny 'greenish globules', peculiar objects that resemble sticks—short and long sticks—all linked together into threads, infinitely finer than the thinnest thread of silk.



Anthrax bacilli

Koch pauses for a moment to think: 'Could these sticks be the germs that cause anthrax? Davine and Rayer, those Frenchmen, have already declared them to be so, but that is pure guess-work. They give no proofs. How can I find out the truth about these sticks? Are they alive, I wonder! Possibly they are like tiny bits of straw with no life in them. No, let me find out if they will grow. I do not find them in the blood of healthy sheep...Ah! Now I have it. I shall insert these sticks into the blood-stream of healthy animals, and then watch for anthrax to appear. If it does, then these sticks are the germs of anthrax. If it does not, then I shall have to start my search all over again.'

Koch—poor, struggling, short-sighted Koch—finds that cows and sheep are too costly for his meagre purse. He falls back on mice for his experiments. Koch does not possess the much needed syringe. So he uses thin slivers of wood. He cleans and heats the slivers to kill all possible microbes living on them. He dips them into the blood of an animal which has died from anthrax. He makes a cut below the tail of a healthy struggling mouse and inserts the poisoned slivers inside it. Next morning Koch finds the mouse dead, and black! He removes the mouse to his dissection-board and cuts open its abdomen. It is a typical anthrax-murder case. The spleen has enlarged and turned black. He finds the blood swarming with the sticks and threads he has witnessed before. He cannot have inserted more than a hundred germs with the wooden slivers. Now they have grown into millions. This is clear evidence that not only are these sticks the cause of anthrax, but they grow and multiply at a rate which is alarming, thus killing the victim.



The 'hanging drop'

'But I must watch them grow. How can I do this? That is the problem of problems. With my microscope I cannot look inside a mouse which is alive. Then how shall I do it?' puzzles Koch.

The problem defies solution for days. He thinks of a hundred impossible ways, and rejects them. At last his ingenious brain finds the answer. He takes a clean glass slide, puts it through a burning flame to destroy all microbes. Now he places on it a thin strip of tissue from the diseased spleen of an anthrax victim. Along with this, he puts the liquid from the eye of a freshly slaughtered ox. He sticks the slide and its contents, with vaseline, to a thick block of glass in which a hollow has been scooped out. Now he can study at leisure the developments in the spleen tissue. There is room for growth, and yet no outside microbe can hope to get inside this sealed well. Koch calls his simple contrivance the 'hanging drop'. He puts it under his beloved microscope, and watches intently. Minute multiplies into minute, and the clock strikes the hour twice, but the eye of Koch is patiently glued to the microscope. Nothing is happening. Occasionally he sees a lonely stick float by in the ox-eye fluid. That is all. To refresh himself, he withdraws from the microscope, rubs his

eyes hard, splashes them with water, and goes back again to look at the 'hanging drop,' as if his life depends upon what he sees.

'Now what's this? Those two small rods were one a minute back. Look at this one now. It is like a worm, a long jack-in-the-box, the way it is pushing itself out. There! it has split into two!'

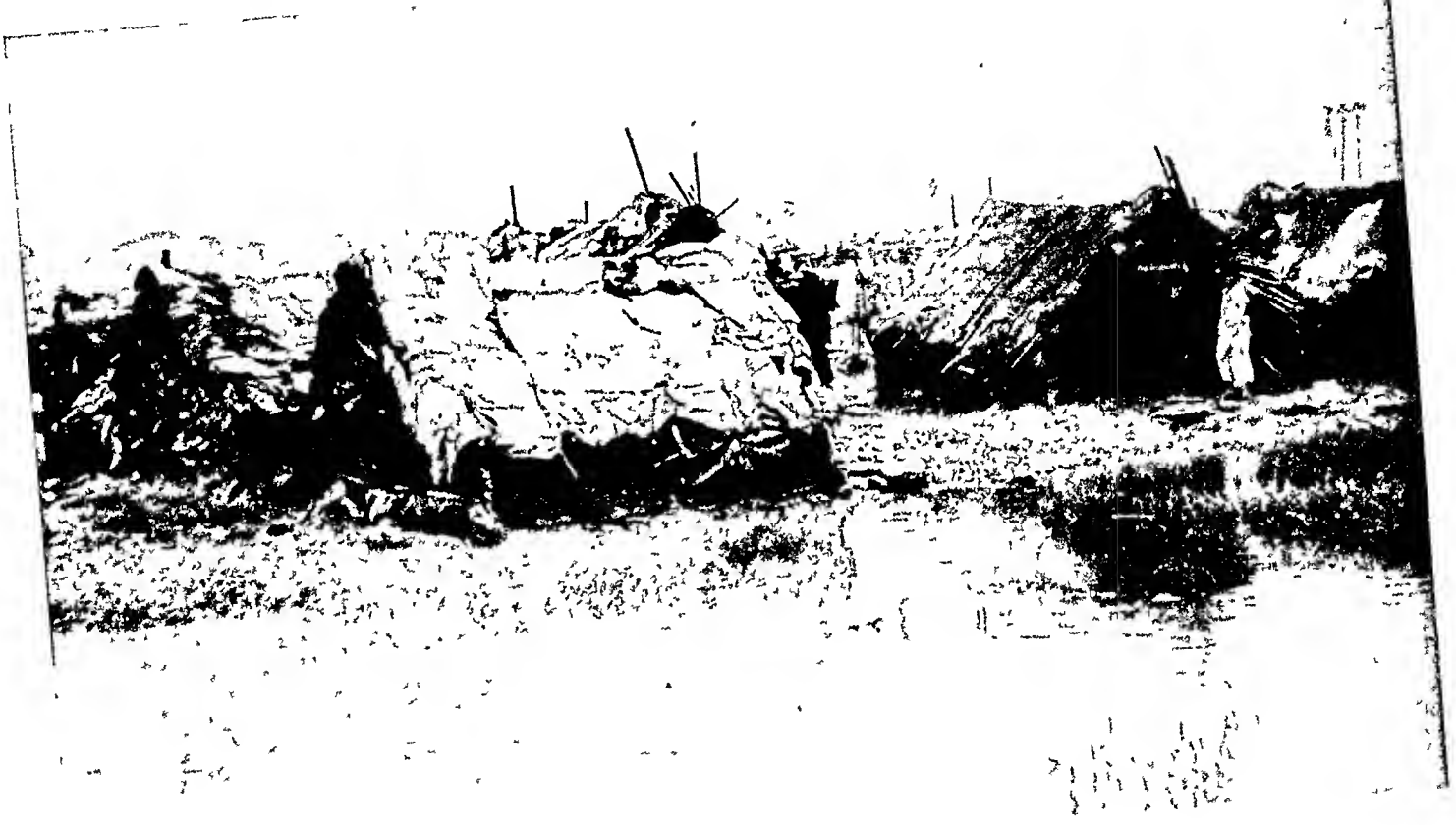
The clock goes on inexorably ticking away the minutes. Twice the minute hand completes the circle. Now the spleen-tissue is no more visible. Millions of tiny rods, ever multiplying, cover everything. And still more millions are being born at a furiously rapid rate. Koch now knows why a single bacillus of anthrax, once it finds lodging-room in the biggest cow, can soon breed generation after generation of millions of germs, and ultimately choke up every blood vessel—the lungs, the heart, the kidneys, and even the brain. What a horrible suffocating death!

Koch repeats his 'hanging drop' experiment every day for a week. Each day he takes a drop from the last 'hanging drop', and places it in fresh ox-eye fluid. Each day the bacillus multiplies a billion fold. He has now the eighth generation of the original mouse-spleen bacillus he sealed in the first 'hanging drop'. He puts a drop of this on fresh wooden splinters, and infects a healthy mouse. Once again the bacilli multiply, this time in the body of the mouse, and kill it.

Once a murderer always a murderer. It does not matter whether the victim is small or big. One tiny bacillus, even of the hundredth generation, is enough to rear a whole army of hundreds of millions. It seems ridiculous that a bacillus so small, invisible to the naked eye, has the potential strength to destroy huge animals. It is as if an ant can uproot and destroy Everest! And yet it is true. Koch repeats the experiment times out of number on guinea pigs, rabbits and sheep. There is no room left for doubt any more.

Yet he has not finished with the anthrax bacillus. He has to find out how the bacillus travels from a sick animal to a healthy one. It dies on his glass-slides in a matter of two days. How do these germs keep alive in the fields, once their host is dead? How do they keep alive for months and years, and through the bitter cold of winter, when a slight lowering of temperature on the glass-slide, is fatal for them?

By accident, Koch stumbles on the explanation. One day he comes across a 'hanging drop' which has remained forsaken for twenty-four hours at the temperature of a mouse's body. He finds that the sticks and threads have developed tiny beads which glitter like silver. He dries the 'hanging drop' and puts it away safely on a shelf. After a month he finds the dried beads as lustrous as before. He puts



Huts in Matunga Labour Camp, Bombay City.
A breeding-ground for malaria and disease

Grace and dignity in a poor home. Gypsies from the North-West Frontier Province, with all their belongings in their tent

fresh ox-eye fluid on the dried beads, and lo! the beads once again change into the bacilli of anthrax. So, that is the way they keep alive! The microbes have dried up, but not before the beads or the spores have had time to form. And for this, body heat is necessary. Once the spores have formed the bacilli are immortal, and can live through the coldest blizzard for hundreds of years without any nourishment. As soon as the spores are lodged in fertile ground, as soon as they get inside the blood-stream of a healthy animal, they again get transformed into living active bacilli intent on murder. A surer death-agent cannot be found. Koch has caught the murderer red-handed. It is now easy for Koch to piece together the threads of the murder mystery.

Caricature of Koch raising bacteria and fungi

An animal dies of anthrax; the spores form inside its dead body as long as the body remains warm. Once the spores have formed they live on indefinitely, even though dried up. They lie in wait for the next victim in the dust and in the grass in the fields. Once having got inside a healthy cow or sheep with the grass it has eaten, the spores come to life again, and the bacilli split and re-split, till the army of murderers becomes sufficiently formidable to squeeze the life from the body. Thus the cycle of death begins again.

The great day in the life of Koch has at last arrived. Overnight he becomes famous. His name is splashed in the science journals of all European countries. Koch has established beyond the vestige of a doubt that microbes are the hidden agents of disease and death. He has proved that a single microbe is sufficient to begin a scourge which will wipe out a population of thousands of cattle. Koch also claims that one kind of microbe, and one alone, is responsible for a particular disease.

Koch goes to the meeting especially convened in his honour by Professor Cohn, the famous botanist of Germany. He does not lecture the learned men of science who gather to hear him at Breslau; he just shows them what he found and how he found it, by repeating his experiments in front of them. The practical Koch, slight-

ly stuttering in his speech, tells them his conclusion. 'It is possible to root out the anthrax disease if a few elementary precautions are taken. All animals that die of anthrax must be destroyed at once. If they cannot be burnt, they should be buried deep in the ground where the earth is so cold that the bacilli cannot transform themselves into the tough long-lived spores. Our cattle can be saved from this lurking danger; but not by applying leeches and feeding them with pills and potions. I have shown you the enemy. Let us exterminate the race of this bacillus.' Science conquers another superstition—anthrax—the supposed 'curse of god'.

Page from Koch's note book showing the life cycle of the anthrax bacilli

From 1878 to 1880, Koch trains himself in the art of staining all kinds of bacilli with dyes of different colours, so that the smallest microbe can be easily picked out by the lens. In a moment of inspiration he attaches a camera to the eye-piece of his microscope. He records what he sees by photographs whose veracity is impossible to challenge.

'Two men cannot look through one microscope at the same time, and no two men will ever draw the same picture of a microbe. So there will always be wrangling and confusion Photographs cannot lie. Ten men can study them and cannot fail to agree as to what they see.' In one brilliant sweep, Koch lifts the science of microbe-hunting from the realm of contradictory observations and cross-claims, and sets it up high on the peaks of factual certitude.

Koch is now appointed Extra-ordinary Associate of the Imperial Health Office in Berlin, and the German Government places at his disposal a first-class laboratory, new apparatus and two assistants.

At this time the world of science is torn into factions in the great 'Battle of the Germ Theory'. Koch tucks up his sleeves and goes into the thick of it with his newly-found instruments in the laboratory.

Koch sets himself a problem: 'I must find a method of growing one kind of germ in isolation from all others. In the soup they get mixed up. I must be able to study one species without contamination from other species.'

He racks his brain and labours fruitlessly for many a day for a solution. Then another accidental occurrence opens a path to him.

He boils a potato, and leaves half of it exposed on his table. It lies neglected for some days, when his eye catches different coloured spots on the cut surface—yellow, and gray, and red, and green—a veritable feast of colour! The curiosity of Koch is aroused. Out comes the microscope. Slide after slide, each bearing the pigment from one coloured colony at a time, takes its stand under the searching gaze of the eye of science. Each colony evidently harbours a single species of microbe; the grays differ from the greens, as the reds differ from the yellows. One species is round, another resembles long sticks, the third looks like corkscrews.

Koch has solved his problem; now it all seems so easy. However, you must realize, it is not a case of mere chance or accident. Solutions and explanations of all problems with which science is faced are already worked out by nature. Nature lays them out right under our noses, but it requires the eye of the trained, hard-working, conscientious worker to spot them and understand them. If Koch was not an inquisitive man, a man of science, he would have thrown the potato into the dustbin. With it would have gone a chance of unravelling the mystery that surrounds microbes. Hundreds and thousands of housewives daily throw away millions of rotten potatoes. It requires a Koch to examine and re-examine and discover pure cultures of microbes.

Now Koch writes, 'Everyone of these droplets is a pure culture of one definite kind of microbe—a pure colony of one species of germs. How simple! When germs fall from the air into the liquid soups we have been using, the different kinds get all mixed up...But when different bugs fall from the air on the solid surface of this potato—each has to stay where it falls...it sticks there...Then it grows there, multiplies into millions of its own kind, an absolutely pure race!'

Soon Koch makes his own substitute for the rotten boiled potato. He now grows pure species of microbes on the smooth solid surface of gelatine mixed with beef-broth.

In 1880 Koch faces the International Congress in London with his discovery of growing bacteria on solid media. A fundamental step in the development of bacterial science is approved and applauded by all. Pasteur, the great French scientist, walks up to Koch the German, whom he normally hates as belonging to a rival nation, and says: 'This is great progress!' The narrow boundaries of

national patriotism break down before the urge of the universal spirit of science in the service of humanity.

Now Koch is ready to take up the fight against the bacillus of tuberculosis. The next letter will tell you about it.

Yours affectionately,
MASHI

LETTER XI

THE WHITE PLAGUE: TUBERCULOSIS

LINA AND VIJAY,

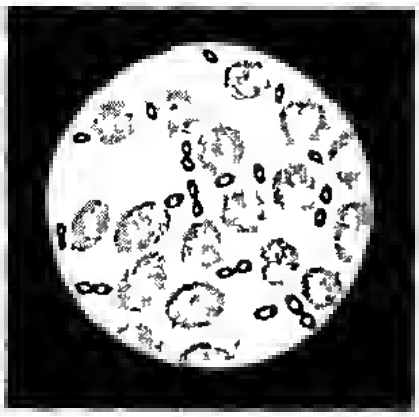
The cause of tuberculosis—the king of diseases and the disease which has not spared kings—was one of nature's closely guarded secrets when Koch, like Saint George, goes in pursuit of this disease. The dragon has already spread terror over the whole earth, and has swallowed year after year one out of every seven human beings. It has contemptuously passed by the lenses of painstaking Leeuwenhoek and ingenious Spallanzani, and laughed in the face of the great Pasteur, who has neither the patience nor the thoroughness in his method to overpower and subjugate this man-eater.

Koch is flushed with his conquest over the anthrax bacillus. He is now increasingly restless with the ambition to corner another enemy of mankind. Very confidently, he focusses his microscope on consumptive tissues from the lungs of a stout young victim. The man was a labourer, thirty-six years old, in the full vigour of his manhood. He worked hard, felt the bulge in the muscles of his arm, thumped his strong chest, and vainly believed in the dream of a long life of a hundred and twenty years. The dragon heard his boast. Stealthily it caught him with its blood-soaked talons, and in three weeks squeezed him to a coughing, blood-spitting, weight-losing creature, uninterested in life. His relatives and friends rushed him to hospital. Four days of torture follow, and then comes merciful death. His body is teeming with tubercles.

Koch believes that victory will be easy in this new venture. Uttermost defeat faces him. Koch can find nothing, nothing on which to hang even the thinnest thread of an hypothesis.

But Koch does not have a weather-cock disposition and is not deflected from his task by this set-back. The fog in which the dragon has enveloped itself has to be pierced. Koch brings out his stains. He uses brown and violet and many a colour which the rainbow suggests to him. He stains one slide deep blue. Just as he is getting tired and gets up to retire for the day, the blue slide attracts his attention. There is nothing special about it. But he feels an urge to look at it once again before he leaves the laboratory table. The microscope swings into focus, and casually, all too mechanically, Koch's eye begins the inspection of the slide. Wait, wait, what is this? Surrounded by the broken diseased cells, there are blue coloured rods,

very thin rods—about the fifteen-thousandth part of an inch long. All thoughts of rest fly from the overworked mind of Koch. He is tense with excitement. It is like peeping through the slit in the wood of a closed door and catching sight of the elusive murderer, dressed immaculately in blue, and with the evidence of murder lying all about him.



Bacilli of tuberculosis

'These bacilli are not straight like the anthrax bugs. They have a curved outline. They are as thick as a cluster of stars on a clear summer night. I have never seen them before. Could they be the cause of tuberculosis?' ponders our Saint George Koch brings out his blue stain to play on tissues from every part of the consumptive's body. These bacilli are very much there. He grounds the hard tubercle specks into powder and injects rabbits and guinea pigs with it. The innocent animals soon develop galloping consumption and die. He splits open their bodies, and with his blue-stain traces the murderer, the curved bacillus, once again.

'Now watch my friends,' he tells his colleagues. 'One little speck of tubercle I put into this rabbit nearly forty days ago. There were certainly not more than a few hundred of these blue gentlemen in that speck. And now they have multiplied into millions. I put the tubercle speck in the eye of the rabbit. From there these gentlemen surreptitiously slipped into every organ in its body, and even pierced the wall of the kidney, the casings of the veins and arteries, the bone-joints and the brain-tissues! For a time they appeared sluggish and inert, and now they are like the waters of a swift-flowing river in flood, permeating and sweeping away every hamlet, every tree, on both the banks.'

'Herr Doktor, you have chiselled your name for the second time on the memorial tablet of medical history. You have located the tubercle bacilli!' exclaims one of his students. The exact scientist in Koch shouts back, 'Now, now, you are being swept off your feet by emotion, and emotion must not be allowed to tamper with cold logic in science. I must first grow these bacilli as pure cultures, and breed them for several generations away from any human or animal medium. After that, if the bacilli still produce phthisis, then alone can one be certain of their mischievous character. So, hold your soul

in patience. In science you must never count your chickens before they are hatched.'

Koch has now a fresh hurdle to clear. The bacilli he collects refuse to breed on his beef-broth jelly or the varied soups he prepares for their benefit. Koch is almost at his wits' end as experiment after experiment ends in failure. His experience tells him that tubercle bacilli are finicky individuals; they will not live any and everywhere, nor feed on stray food that is thrown to them. They prefer living bodies, human or animal. So his jelly has to be made of stuff which will resemble them. Thus he arrives at the brilliant idea of preparing blood-serum jelly.

Koch now makes friends with a butcher and collects serum from the blood of newly slaughtered cattle. He removes all possible microbes from the serum by heating it, and then fills his test tubes with it. When the jelly is set—on the slant, in order to offer the largest surface for the bacilli to breed—he is ready for the experiment.

Koch turns his attention to the latest victim of tuberculosis, a guinea-pig. His platinum needle is ready. Again and again he dips the needle into the grayish-yellow tubercle tissue and contaminates the jelly in the test-tubes. After this, the test-tubes are placed inside an incubator, with the atmosphere regulated at the body-temperature of a guinea-pig. Now begins a long vigil. Night follows day fourteen times, and hope, which is always so strong and alive in Koch, feels the strain of peeping at the test-tubes dozens of times every day and finding no change—no growth—no stir in the tubercle tissue world, sitting calmly in the jelly with a statuesque pose.

What is true for fourteen days, does not apply to the fifteenth. Koch's eye glistens with a knowing light. The tiny specks actually look bigger. The microscope swings into animated action once again. There they are, the bacilli he first spotted with his blue stains! Koch's imagination is inflamed. 'These insignificant tiny rods, with the most graceful curves, the slender body and rounded ends—they are potentially more murderous than a rice-field alive with a thousand vipers!'

With the precision of a seasoned scientist, Koch repeats his experiment on cattle, on monkeys, on guinea-pigs, till he has forty-three rows of test-tubes, full of bacilli—enough to wipe out the whole German nation. Now Koch transforms his laboratory into a Noah's Ark. Rabbits and guinea-pigs, rats and mice, a hen and a cock, monkeys and sparrows, a tortoise, frogs, eels, and even a goldfish

are hidden away in different corners of Koch's ship of science. Like Arjun exhorted by Sri Krishna, on the field of Kurukshetra—not to falter in his duty to kill his own relatives because they have already been marked out for death—Koch now attacks each animal with his syringe, loaded with the poisonous bacilli from his rows of test-tubes.

The goldfish, the eels, the tortoise and the frogs remain immune —none the worse for the poison. But the rest of the animals develop tuberculosis, and soon collapse.

Koch searches for a flaw in his experiments. Is there a loophole by which the bacilli can escape? 'I injected the bacilli into them. That is surely not the way the bacilli enters human or animal bodies! It is through the inhaled dust that the bacilli normally ride into the throat and lungs of a victim. I must give tuberculosis as nature does.'

So Koch performs another experiment. He locks up healthy rabbits and guinea-pigs in a big wooden box. Through a lead-pipe he pumps the bacilli into it every day for half an hour. The rabbits are the first casualties; they die in ten days. The guinea-pigs give up the struggle on the twenty-sixth day. They are all victims of tuberculosis—seething in every pore with tubercle bacilli.

Day after day, Koch lives through the chaos of his test-tubes, the squeaks of his rabbits, and the grunts of his guinea-pigs, a happy man. Out of this chaos is born a glittering star—a shining bit of knowledge—which will inspire generations to come with new hope and a possibility of winning in the seemingly hopeless fight against consumption. Koch is happy because he has served mankind concretely, practically, and not in the vague manner of sermon-preachers.

Yours affectionately,
MASIH

An Assamese peasant family

An old woman suffering from malaria,
in an Oriya village

LINA AND VIJAY,

From time immemorial, the world has had a great horror of tuberculosis. In some of the earliest records of human history—the cuneiform inscriptions on tablets in the remains of the grandeur that was Babylon—we find suggestive references to it. In the Bible, where Moses threatens the disobedient with the curse that shall visit them, and in the Talmud where certain cattle are ostracized, we find hints of the existence of this wasting-disease in those ancient times.

Laennec

We reach firmer ground when we meet Hippocrates, and later on Galen, because of the detailed description of phthisis they record, and the contagious nature of the disease against which they warn.

Sylvius and Morton in the seventeenth century describe the tuberculosis nodule. Morgagni and Valsalva so excite public fear that stringent laws are adopted in Italy enforcing the complete segregation of consumptives.

Fear breeds more fear; it is as contagious as the disease itself. Soon it becomes customary all over France, Spain and Portugal to burn the clothes and bedding of a consumptive.

The next landmark in the history of tuberculosis is Bayle, who is recognized by the modern physicians as the founder of the correct teaching about tuberculosis. In 1803, he clearly describes the three stages through which a T.B. patient passes. He also counts six different kinds of phthisis.

Laennec is the next medical man in the T.B. hierarchy who describes the physical signs that accompany the disease. He swears by the 'Unity of Tuberculosis', but falls into the error of calling it non-contagious. Virchow opposes the findings of Laennec about 'Unity'. He declares that the disease in the different parts of the body is a separate entity. In 1868, Villemin reproduces the disease in animals, and thus proves beyond a doubt its infectious character. His experiments however remain unacceptable to the majority of doctors.

Eleven years later, Cohnheim and Salomonsen take up the thread of Villemin and perform a brilliant experiment, by which the progress of the disease is watched as if in a mirror. They inject tubercle matter into the anterior chamber of a rabbit's eye. They publish their findings. They vouch that they observed the growth of nodules, the disease of the lymphatic glands, and finally acute tuberculosis. Villemin is vindicated.

All this time, the tubercle bacillus is safely hidden—only the effects of its ravages recorded. This minute colourless rod, variable in length and sometimes in thickness, has rounded ends. In the victim's sputum, it grows to the length of half the diameter of a red blood-cell, so tiny is its structure. It evades the eye of the microscope most successfully, until Koch unearths it in 1882 with his blue stain.

In the hands of Koch, tuberculosis is demarcated from the various pneumonias, skin diseases and scrofulous glands with which it was mixed up by earlier medical practitioners. In 1901, he declares human tuberculosis distinct from the bovine variety, which attacks cattle.

Koch prepares his fatal Tuberculin from the culture of poisonous bacilli and proclaims it to be a sovereign remedy for the disease. Nothing succeeds like success, thinks the Prussian Government, which forces Koch to depart from the golden rule of science: he is driven to publish his investigations for a cure, before he has thoroughly tested the remedy. The result is fatal to his reputation. Anger and harsh words greet him when inexperienced medical men kill rather than cure with Tuberculin.

We can sometimes estimate a man's character better by the pitfalls he failed to avoid rather than by the magnitude of his success. Like the sun, success dazzles the eye and exaggerates his shadow a hundredfold; failure strips the cloak from his back and presents him to the world in all his nakedness. Even in his failure, Koch remains the sober scientist, owns his mistake and turns it to future use.

Since the days of Koch, during the swift-moving twentieth century, research keeps closely on the trail of the bacillus. Many more facts about its ancestry, its growth, its habits, its potentialities, are brought to light. The disease kept the secret of immunity and cure for centuries. But man has now forged new weapons in his laboratory, and today T.B. is a conquered disease.

Now we know that there are actually four different kinds of tubercular bacilli: the human, the bovine (of cattle), the avian (of birds),

and the piscine (of reptiles and fish). The last two are never found in man. The human type cannot infect birds and fowl, and only causes lesions in cattle. The bovine type is fatal to pigs and rabbits, as it is to man.

Tuberculosis affects domesticated animals and animals confined in a zoo; it is rarely found in sheep, horses, dogs or cats in a wild state. Rabbits and guinea-pigs are susceptible to the disease when inoculated on the laboratory table, but in nature they hold the immunity password.

Scientists assert that tuberculosis is essentially a disease of civilization. For instance, the continent of America was said to be free from this pest until the white successors of Columbus took it along with their other gifts of civilization to the American Red Indians. From the racial point of view, it is found to be fatal to negroes, the Hawaiians, and the mixed-blood mullatoes, though surprisingly its incidence is low for the Jews as a community.

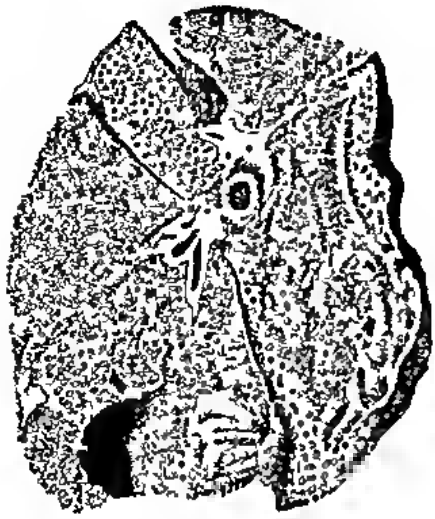
Consumption, however, is no respecter of sex, and attacks man as well as woman. It prefers victims between the ages of eighteen and forty-five. Nearly one-third of the mortality during that age is claimed by it alone.

Experiments by Hamburger have brought to light the interesting fact that by the age of twelve, or the maximum eighteen, nearly nine out of ten persons are infected by the bacillus. Tuberculosis at birth is a rare phenomenon. It is acquired from the environment round us. Even the child of a tuberculous mother is free from the disease, if it can be segregated immediately after birth—if the mother does not make the mistake of feeding the child from her own breast. About ten per cent of the children get it in the first year; the figure rises to fifty per cent by the time they reach the age of six, and ninety per cent when they are declared by society to have reached the age of majority.

But all those who are infected, do not become active cases. We are all delicately balanced between immunity and susceptibility. We can nurse the bacilli for a life time and be none the worse for it—not even registering low fever or elementary symptoms of the active disease.

Lesions and the bacilli can be overcome by the human body, provided the bacilli infection is small and not very frequent. Repeated infections bring on the fatality though much depends on the resistance the body can put up. That is the reason why it is said that occupation and social conditions have an intimate relation to the mortality

ratio. Stone-cutters, cigar-makers and plasterers answer for half the T.B. deaths in the U.S.A.; over ninety per cent of the rest of the tubercular victims are from the poor.



A section of the human lung perforated by nodules of acute miliary tuberculosis

Tuberculosis is a chronic disease stretching over months and years, rather than hours and days. The sly, unobtrusive bacilli lie in wait for a favourable opportunity to become active and bring about death. The resistance power of the victim must be low. He must become weak and debilitated. The bacilli watch silently when poverty gives rise to filth, bad ventilation and overcrowding. Once the bacilli have gathered in sufficient numbers, they invade the poor victim mercilessly. With the impatient fury of hungry famine refugees, the bacilli eat into the lung or the intestine, whichever be the affected part. They breed in millions and sometimes float in the blood-stream, befouling the banks wherever they lodge. Death can now make an entry in its diary about the date on which to send his messengers to fetch the victim.

The murderers celebrate a gala tournament inside the fast-decaying body. To the accompaniment of the resounding music of the dry, hacking cough, with the arena decked in red blood from haemorrhage, the pulse beating faster and faster, the atmosphere rigid with low evening fever, the bacilli bait their victim and slowly squeeze all interest in life out of him. The victim sweats profusely at night and early morning; he loses his appetite for the most savoury foods; his weight goes down systematically; strength oozes away from day to day; his face assumes a deathly pallor with two bright patches of colour on his cheeks; his chest becomes more and more flat-bottomed; anaemia advances; pain and insomnia take a hand; diarrhoea aggravates the declining pace; his fingers get clubbed; and the end is not far off. All this time, a continuous caravan consisting of new generations of bacilli marches out triumphantly riding on the shoulders of the sputum of the doomed human being in search of fresh victims.

The cannibalistic bacilli prefer to feed on the lungs when their prey is an adult man or woman; their palate chooses the soft bones, the joints and the lymphatic glands when they eat off children.

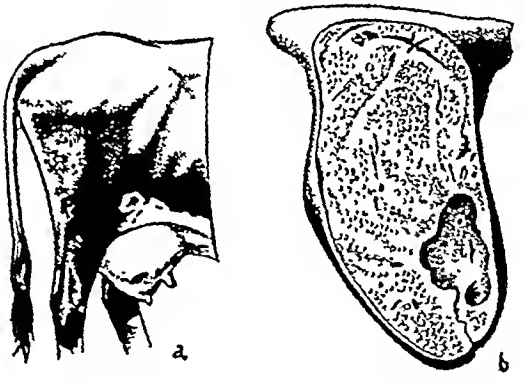
The problem of how the bacillus lodges inside the body of its victim has caused many scientists years of worry. They have argued round different hypotheses, and have proclaimed enough doubts to make the foundations of every theory shaky and unreliable.

And yet some facts appear to be beyond dispute. Most research workers agree that there are four recognized modes of infection: heredity, inoculation, ingestion and inhalation.

Heredity is now universally dismissed as a likely cause of infection. A tuberculous father has never been known to pass the bacilli in his sperm, or the consumptive mother give it to her unborn child inside the womb through the placenta.

Inoculation is also rare, and is mainly confined to careless butchers or post-mortem workers.

Ingestion is through the act of eating food or drinking milk. The bovine bacillus has travelled to man through the udders of a tuberculous cow. Boiling milk before drinking it definitely removes the danger. The boiling however must not be formal, nor must it be overdone. If the heat applied is not sufficient, the microbes will flourish; if too much heat is used it kills not only the bacilli but vitamins also. It is here that the great discovery of Pasteur has come in useful. Pasteurisation means boiling at 130°F, well below the boiling point, for at least half-an-hour. This is sufficient to kill the tubercle bacilli and not destroy the vitamins.



(*a*) Tuberculosis of the udder of a cow. Note the swelling of the mammary gland
(*b*) A section of the udder. Note the cavity caused by tuberculosis

When infected milk is drunk, the bacillus either lodges in the tonsils or in the alimentary canal, and floats away at leisure to the lungs or the stomach, as the opportunity may offer. Uncooked meat from tuberculous cattle opens up the same dangerous avenue for the bacillus to slip into the body.

In a modern well-planned society, all these three sources of infection are kept under control.

Inhalation is the disputed source of infection we have yet to examine.

Nuttall calculated that a moderately advanced tuberculous patient throws out anything between two and four billion bacilli in every twenty-four hours.

Experiments show that droplets of sputum are suspended in the air for hours after each fit of coughing, sneezing or loud talking. The droplets ultimately dry up, and the bacilli land wherever a passing gust of wind deposits them. They remain alive in dried sputum even after two months of ejection from the mouth or the nose of the last victim. The bacilli behave as if they are dead. After that any and every dust storm or even breeze is sufficient to pick them up and waft them inside the unguarded mouth and nostrils of an unwary traveller. Once installed in congenial surroundings, they soon bestir themselves and begin their work of boring from within.

The bacilli are very difficult propositions. If you boil them in water sizzling at a temperature of 100°C, they look perfectly dead but require not more than sixty-minutes of drying to be up and about once more. They thrive in gastric juices which destroy many other kinds of bacteria. Their idea of a real luxurious comfortable home is a place where the temperature ranges between 29° and 42°C, oxygen is moderately supplied, moisture is present, and good protection from the sun's rays is obtainable. They abhor carbolic acid solution of one-in-twenty strength; it kills all the joy of their nefarious life.

As against the theory that the bacilli are carried about by dust storms, there are scientists who get red in the face and thump the tables very hard when they declare that no living tubercle bacilli have ever yet been found in street-dust. They affirm that searches in bed-clothes, curtains, furniture, rugs, drinking cups and plates, telephone speakers and so forth, have been equally unavailing

It is not necessary for us to make ourselves the targets of the raised lances of these infuriated scientific crusaders, belonging to one school or the other. We shall rest content by learning from the cautions on the notice-board put up by men of science:-

BEWARE!

SOURCES OF DANGER:

Soiled hands of midwives and doctors at confinements.
Sputum-soiled fingers of any and everybody.

Nipples of milk feeding-bottles for children.
Fingers and toys of infants sprawling on the ground.
Hands and nails of people in consumptive houses.
Handkerchiefs used for spitting.
Spitting in the street, on walls, on staircases.
Coughing without covering the mouth.
Sneezing without shielding the nose.
Towels used in common.
Drinking from common glasses and cups; eating food with contaminated spoons and forks.
Food on which flies or cockroaches have descended with their poisoned feet and fangs.
Unwashed dirty linen.
Kissing pet dogs just returned from play in the street or from neighbours' gardens.
Habit of sucking pencil-ends.
Thumbing library books with sputum.
Counting currency notes by wetting the thumb and forefingers with spit.

In all these lies the danger of tuberculosis. Tuberculosis spreads like influenza, by microbes discharged from the mouth and the nose. As a good citizen you must not be a party to spreading this curse of our civilization.

Learn to wash your hands and mouth before you eat. Clean habits clean up tuberculosis.

We shall leave it to the scientists to contest whether any item in the above list gives us consumption or not. In the meanwhile, we shall do well to study cleanliness and form hygienic habits. They hurt nobody. They help to stave off many diseases, especially tuberculosis.

In the meanwhile, the scientists are not resting on their oars. I read the following news item in a newspaper. It speaks for itself.

STREPTOMYCIN AND T.B.

Tests on tuberculosis patients under Ministry of Health direction will begin within six weeks at selected British Hospitals to discover whether the new drug Streptomycin can effect a permanent cure. Streptomycin, cousin to penicillin, is now being produced on a large scale in Britain.

Preliminary tests on animals at Nottingham have produced cures, but Sir Jack Drummond, former Chief Scientific Adviser to Lord Woolton's Food Ministry, says that it will take three or four years to decide whether it is effective in the case of humans. Every authority has been warned against undue optimism and it has been

pointed out that evidence that it will cure humans is still not conclusive. It has however shown good results in cases of typhoid, paratyphoid, cystitis, meningitis and whooping cough. Supplies will be prohibitively expensive for a long time. The drug has been discovered in the United States and clinical tests are also going on there.

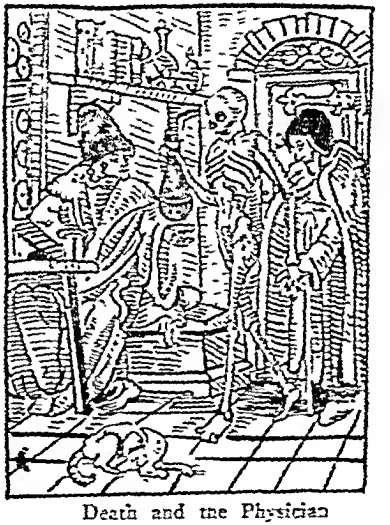
From prevention and immunity to cure is a big step. But we may not be far from it.

Yours affectionately,
MASHI

LINA AND VIJAY,

You can legitimately argue: now I know everything worth knowing about the bacilli—how it was discovered. how it attacks human beings, the different sources of infection, and the care I must take in avoiding the disease. That is all very well as far as it goes. But suppose I have already caught the disease. After all. no less than two and a half million of our countrymen are active tubercular cases. and half a million die every year due to the scourge. What then is the best treatment for a tubercular patient? In what way can we fight and annihilate the bacillus once it is aggressive inside the body?

To be frank. scientists have so far failed in finding a remedy for the disease. They have evolved no specific drug, vaccine or injection by which the bacillus can be wiped out from the human body suffering from its ravages. But there are a number of effective makeshift arrangements.



Death and the Physician
—Woodcut by Hans Holbein

The first thing that any honest physician will tell you is that in tuberculosis, all that he can do is to keep an eye on the bacilli and note the growth or abatement of the disease. The other thing he can do is to suggest ways and means of aiding nature, strengthening the body to overcome the poison and reducing the bacilli to impotency for the time being. The physician can only help, for the stage is principally occupied by the patient himself and his physical and mental resistance. Let us examine a model prescription which a wise medical man would write for a T.B. victim.

REST IN BED	Eight hours sleep at night, plus one hour before lunch and dinner.
RELAXATION	No mental worries.
FRESH AIR	Windows and doors open day and night; get out of congested cities into open country.

WARMTH	Must never be cold or wet; warmly clothed though not heavily clothed.
DIET	Simple digestible food sufficient to cause gain in weight; forced feeding prejudicial; no alcohol; insulin may be helpful, as also cod-liver oil, creosote, hypophosphites, calcium, arsenic, and so forth, to be taken under the guidance of a physician.
EXERCISE	Very graded; temperature to be a guide to the burden of exertion; after rest of one hour, temperature in rectum must get back to normal; no physical exertion which would entail exhaustion.
CLIMATE	Dry, warm climate, without dust or sand storms; a lot of sunshine; sea coast, good for chronic cases; sea voyage, only in convalescent stage; high altitude suitable for early or advanced quiescent cases, but undesirable for active cases.
WEIGHT	To be increased gradually; weekly twelve to twenty ounces; rapid gain inadvisable.
CLEANLINESS	Next only to godliness; no dirt; no over-crowding; simple clean habits.

If the patient follows this regimen, not for a day, not for a month, but until he has been cured, he will have won the day. If he mopes, continues to work hard beyond the capacity of his broken body, continues to live in ill-ventilated, unhygienic, crowded houses, and eats an unbalanced diet, he is a lost soul, with a heart full of leaden despair, with one foot already in the grave, with the other closely following behind.

Science places at our disposal several aids by which we can be certain that the disease is T.B. We must acquaint ourselves with these. The physical symptoms of the disease can be very deceptive. A microscopic examination of the sputum, when it gives a positive result, is conclusive proof of the disease. If the bacilli are absent, we will have to turn to the X-ray apparatus and screen the affected part. Radiography reveals the extent of the damage, and thus helps to check its further spread.

Koch evolved the subcutaneous Tuberculin test. It is now universally abandoned, because it proved to be dangerous to the patient. It had the possibility of accentuating the activity of the bacilli. Other vaccines on the same principle prepared from the pure cultures of tubercle bacilli, are still in the stage of experiment.

If the patient suffers from lung tuberculosis, the scientist has evolved a special method of resting the diseased lung and thus giving it breathing space—time and leisure to overcome the damage caused by the bacilli. It is called artificial pneumothorax. The principle is simple and understandable. Air is pumped into the potential space between the affected lung and chest wall, with the result that the lung collapses, and remains out of gear.

In cases which are of a long standing, the lung gets stuck to the chest wall—there are adhesions, and this method of collapsing it is not practicable. Human ingenuity has evolved another method to meet the case. The surgeon cuts the ribs in front and behind, allowing the ends to drop down and in, 'like the handles of a bucket', thus producing the same result. They call this thoracoplasty.

When both these methods are not advisable, another operation is undertaken. This is the crushing of the Phrenic nerve. This causes temporary paralysis of the diaphragm, which may last as long as six months, ensuring sufficient rest to the lung on the paralysed side.

Apicolysis is yet another mode of surgical treatment. Some extraneous material like paraffin is introduced between the chest-wall and the pleura.

The principle involved in all these operations is the same. The affected part is not to be irritated, and therefore must be rested, so that the damage may heal by natural process, while the body is simultaneously helped to overcome weakness and general debility.

Various injections with gold as a principal component have also been prepared from time to time by scientists. Gold was once a great favourite ; then its popularity declined ; and now it is once again finding favour with the physicians. These injections have not yet proved to be infallible, but in early cases have shown good results.

In 1921, Albert Calmette and Camille Guerin of the Pasteur Institute of Paris prepared the BCG vaccine—Bacillus of Calmette and Guerin. They use it for new-born children and adults. The theory is that when you are born, you are free from the bacillus. Before you are infected, the doctor appears with the immunizing vaccine. It is prepared from cultures of living bovine bacilli, in a dose which is too weak to cause disease but strong enough to create anti-bodies, which protect against the tubercle bacilli when they attempt to invade the human being.

1930 is a fateful year for the BCG vaccine. The doctors in Lubeck, Germany, give it to two hundred and fifty infants; it proves to be fatal for nearly one third of them within a few months. An investigation

reveals that a highly virulent strain of the bacilli got mixed up with the vaccine BCG stands exonerated But the lay public has received a rude shock to its belief in the efficacy of the vaccine

A large number of children of tuberculous parents have been given the vaccine in Soviet Russia, France, Denmark, Sweden and Norway during the first fortnight after birth In Soviet Russia the vaccine has been used on no less than two million people, and as a standard routine injection for new born babies in areas where T B once had strongholds

In Norway, the vaccine experiment is begun in 1927 When World War II approaches, the Government starts a vaccination campaign as a bulwark against privation and food shortage, the pre conditions of a rise in the T B mortality rate

In the U S A, BCG vaccine has only recently been accepted, after rigidly controlled experiments prove its efficacy Dr Aronson of the Pennsylvania University inoculates 1550 Indians with the vaccine, and 1457 other Indians with a simple salt solution Both groups are given the impression that they have been immunized by the vaccine The same squalid reservations and unhygienic huts house them, exposing them equally to T B infection When the records are finally compiled after a period of five years, it is found that forty of the vaccinated Indians have developed T B as against 185 among the non vaccinated This shows that BCG is neither infallible nor a miracle healer Dr Emerson of the National Tuberculosis Association of the U S A declares 'BCG cannot cure It is not even a perfect preventive But wherever exposure to T B infection is high, BCG may provide substantial protection'

In September 1946, the U S Public Health Service calls a conference of T B experts The conference recommends a Central Laboratory to be set up for manufacture of the vaccine for free distribution, but only for research purposes It is calculated that the price of production of a single BCG vaccine required for immunity is little more than one fourth of a rupee The conference has drawn up a plan of mass experiments on Indians, the laboring class and persons employed in hospitals and lunatic asylums The U S A has still not made up its mind about the vaccine

Open air sanatoria in the treatment of tuberculosis are accepted today as essential and indispensable by every civilized person That is not so a hundred years ago There is opposition from the medical profession itself Sneers and ridicule are loaded on the heads of the pioneers of this form of treatment

George Bodington is a medical practitioner in England in 1836. In those days, as soon as the doctor pronounces a diagnosis of consumption, the patient is considered to be doomed to certain death. The suffering invalid is locked up in a room, every door and window being carefully shut. The room is kept hot, 'so that he does not catch cold'. Not a whiff of fresh air is permitted. The condition of the sick man soon deteriorates in this stuffy, unhealthy atmosphere. Not surprisingly, death is hastened to the bedside of a demoralized and forlorn being whose will to get well has been shattered by the ominous verdict.

George Bodington

Bodington is an unorthodox medical man. He believes that 'the only gas fit for the lungs is the pure atmosphere'. He becomes a captive of his own belief, and insists that his patients break through their self-imposed imprisonment. He sends his patients 'to live in and breathe freely the open air'.

Bodington becomes the target of all the vested interests in tuberculosis. The doctors, the druggists and the lay public combine to shout him down as a dangerous man playing with the lives of innocent human beings. George Bernard Shaw in his famous play, *The Doctor's Dilemma,* records: 'George Bodington was ruined and driven out of his practice for only opening the windows.'

He is forced to give up treating consumptives and turn to the care of lunatics and the mentally deranged, such is the fury of the narrow-minded bigots he encounters.

The flame lit by Bodington is not to die out. An act of progress may be smothered by interested parties in the place where it originates, but nemesis soon overtakes them. From some corner of the wide world, from somewhere, sometime, an enlightened man arrives on the scene, is inspired by the glow of the spent torch, lights another torch from the dying embers, and its flame burns with added brilli-

ance. Soon, all too soon, before the dark forest can realize what is happening, the dense woods of prejudice and ignorance are set on fire, and the flame dominates everything. Progressive ideas are like forest fires, once they catch on.

In 1859 Hermann Brehmer establishes his first open-air hospital for tubercular patients. He sets it up high in the Woldenburg Mountains. Brehmer is convinced that consumptives need not die. Has he not seen with his own eyes at the post-mortem table how lungs which have been attacked once by the tubercle bacilli, show cured spots? That is indication enough that T.B. can be cured. He is going to try.

For ten long years he keeps on trying. In the secluded mountain-tops, he is exempt from the rancour of his professional brethren. One day a German medieal student walks up to his sanatorium. Peter Dettweiller has realized he is suflering from consumption, when a sudden gust of blood in his mouth makes him ill. Everybody is convinced of his impending doom. He is in love with life, and life dies hard. He walks up to Dr Brehmer and requests him to save his life. Dettweiller is ultimately cured.

Grateful to the idea that has preserved his life, this young rejuvenated man swears by everything he holds dear that the rest of his life will be devoted to the cure of consumptives. He sets up the first open-air sanatorium which shall work all the year round. He is fired with the zeal of a missionary. And he is not to rest until the idea of open-air treatment is believed and accepted all over the world. He labours for the comfort of his patients. He introduces for them the portable spittoon, and the reclining chair.

In 1868 the flame reaches America and envelops the forest of prejudice in that continent. Edward Trudeau has nursed a dear brother suffering from consumption. He has suffered the misfortone of seeing him die. The medical profession impotently watches the disease slowly and effectively gnaw at the entrails and kill his brother.

Trudeau himself develops symptoms of T.B. Once again eminent doctors are consulted, and once again they shrug their heavy shoulders and pronounce the portentous 'Humph!' a signal that death is more powerful than their limited skill.

Trudeau, like Dettweiller, is not ready to submit to 'fate' so easily. He retires to 'the peace of the great wilderness', in the mountain fastness of the Adirondacks, and later on establishes an open-air sanatorium—the first one to be set up in America.

Robert Louis Stevenson, the distinguished author of *Treasure*

Island, is treated by Trudeau at Saranac for a whole year. The time he spent there is immortalized in Stevenson's story, 'The Penny Piper of Saranac'.

These are the pioneers of the flame. After the dark night of doubt and misgiving is over, the day dawns when open-air sanatoria rise like mushrooms everywhere—wherever intelligent men try to heal patients in the grip of the bacilli. There are no more gatherings of worried medical men—putting their wrinkled foreheads together, avoiding one another's eyes, tongues refusing to shape the fateful words: 'There is no hope, he must die.' No more does life slip away behind the hopeless backs of the men of science. Man fights back with the untainted methods of nature itself. And man has won a considerable part of the race against the tubercle bacilli.

Science points the way to immunity against consumption. Prophylactic measures fall under three main heads: (i) Cure of the infected; (ii) Prevention of infection; (iii) Stamping out the scourge for future generations.

They are all inter-connected, and one measure without the other, is of little value. You cure a patient after segregating and treating him in a sanatorium, with specialists attending on him. It is all wasted effort if the man is to return to surroundings where he will catch the infection again, and begin infecting others. If infection is to be avoided, social and economic conditions must be improved. Each human being must be able to afford leisure to sleep and to play, to have good nourishing food, well-ventilated houses, clean clothes, and a sufficient number of them. Good habits are not much good without the ability to indulge in them. T.B. is as much related to income as it is to price-control and food-rationing.

So, if we catalogue our immediate needs for doing away with tuberculosis, we require the following:

T.B. sanatoria and hospitals, sufficient to treat all active cases. We have in India one bed for every four hundred and sixteen active cases, an absurdly inadequate provision.

Enough trained personnel to treat all cases. There are only eighty doctors specially qualified in the treatment of tuberculosis, about three hundred more who have done a 'short-course', and a hundred T.B. health-visitors in the whole length and breadth of our country with a population of over four hundred millions.

Pasteurisation of all milk supply, especially for children.

Sputum and X-ray examination of all doubtful cases and all contacts of T.B. patients, in order to enable early diagnosis. Mass

miniature radiography is now within the bounds of financial possibility, at least for all school children.

Removal of slum areas and enforcement of hygienic surroundings; better ventilation and less overcrowding in the cities and big villages.

Shorter hours of work to permit more open-air play and more sleep.

Better conditions of work in offices and factories.

Raising the standard of life of the poor and the working-class, so that better food and clothing is possible.

Education:

To prevent
Spitting in public places
Using un-pasteurised milk
Early marriages and frequent pregnancies
Purdah and keeping the home as woman's prison
Marriages within two years of cessation of active symptoms

To enforce
Compulsory notification of each case
Hospital or sanatorium treatment

To enlighten
Regarding causes of infection
About methods of cure

Man in his fight against tuberculosis may be likened to a ship on the high seas, all sails filled to capacity with a steady wind, the restless waves tossing it about, trying to impede its progress. In spite of it all, the ship makes rapid headway towards its destination. Tuberculosis is as wide as the ocean, and as full of dark depths, hundreds of fathoms beneath the swelling waters. The sails of the ship of man are filled with the spirit of enlightened progressive science. The ship will ride the ocean triumphantly, it will avoid all rocks, if the helmsman's hand does not falter. The land of immunity and safety is not far off. There—on the horizon—we already decipher the statue of Immunity raising its glittering torch to welcome us.

Man knows how to sail smoothly through the oceans of tuberculosis. And knowledge is power. It remains for us to use that power to be free from this scourge of innocent and poverty-stricken human beings.

Yours affectionately,
MASHI

A boy suffering from scabies,
in a street in Swarna Town,
Guntur District

Charity is no solution A destitute woman and child arrive at a relief centre in Orissa

LETTER XIV

THE ASIATIC SCOURGE: CHOLERA

LINA AND VIJAY,

Let us imagine we are in the year 1848. Here is Paris in the preliminary throes of an upheaval—a bloody revolution. The current of events is sweeping everybody, big and small. Injustice and discontent awaken the suppressed masses to revolt.

Hatred between the two classes that divide society—the *bourgeoisie* and the workmen—is apparent on every street corner and in every inn. How long can these two hostile camps continue to live in close proximity without a clash? How long? Pent up hatred is hiding behind fixed bayonets, awaiting the zero hour, to let loose hell—spill blood and paint red the brute in man.

Somewhere the drums are sounding. Paris shuffles out of its bed in a hurry, hastily pulls on a shirt, and rushes into the streets in bedroom slippers. The silent streets are now buzzing with many voices, shrill with excitement. The nervous chatter of the impatient crowds flows on like a turbulent brook, when an ominous sound dams it completely. Hushed silence—the knell of doom is striking! The boom of a gun, the shrill whistle of bullets, the reckless gallop of rushing horsemen, and the drone of heavy cannon rolling down the cobbled streets—they make a strange weird orchestra!

Bedlam is let loose. By some immutable law of self-preservation, the crowds now melt away, the streets are deserted. Vociferous humanity of a minute before is now divided into three hushed batches: the groaning wounded, dripping with blood; the silent dead leading the queues to the cemeteries; the glum prisoners, young and old, with hands tied behind their backs, being driven to the prison, their living grave. Paris is no more gay this side of the Seine.

On the other side of the river, man is erecting a mountain, piling it higher and higher in a hasty mess of chairs, tables, windows, doors, benches—odds and ends—which a frantic populace believes will stem the oncoming tide of government cavalry. Women with dishevelled hair and children in a holiday mood join the mad rush to build the magic barricades.

A young stalwart now mounts to the top of the precarious heap, and unfurls the red flag. In a deep husky voice, he sings: 'Allons, enfants de la patrie!' His voice acts like magic on the excited crowd. The windows and doors of surrounding buildings fill up with

struggling heads and jerking hands. Humanity sings the Marseillaise, and clings to the inspiring tune like a frightened child clutching at the skirt of its mother. The refrain of the song climbs higher and higher, skips across the barricades and hits the blood-thirsty faces of the mercenary soldiers.

A shower of lead—poisonous lead—is the answer of the heated muskets. The song sobs into silence.

For four days and four nights this duel continues. At last the 'uprising' is quelled. Law and order is restored. The submission of the masses is complete.

But is it? Paris is beaten, but Paris is not broken. Low hanging brows are afire, eyes flash sparks at the sight of the blood-dyed street-corners. They tell the tale of ruthless repression. Gaping wounds howl impotently for vengeance. The moans of the tortured now torture those who escaped martyrdom on the barricades. Gnawing fear and suspicion cloud faces as reaction rides on triumphant frisky horses through the streets.

In the midst of this tense atmosphere of arrogant laughter, dressed in military uniforms on one hand and impotent frenzy gnashing its teeth in dark, hidden corners on the other, a hushed whisper goes forth; and Paris has already forgotten the revolution in face of this new merciless visitation.

Souvenirs of cholera
—*Etching by Daumier*

What can it be now? The Revolution again? No—it is the scourge—the scourge from the East—CHOLERA!

Panic, panic everywhere. Uttermost defeat is evident on the faces of the people. At the sight of the long line of hearses, they flee in terror. The bonds of goodwill and fellowship that bind society together dissolve. Victims of cholera are left to their fate, abandoned to die a lonely death. Father deserts child, and wife husband; friend refuses to shake hands with friend. There is tragedy—everywhere. The revolution is forgotten.

Conditions become a hundred times worse than in the midst of the worst repression. The scourge reduces man to the pre-historic stage and makes him an anti-social element.

It is a messy and disgusting death. Compared to it, death from a bullet on the barricades is a glorious death—clean, dignified, surrounded by martial glory.

Profuse watery stools, quickly becoming colourless like rice-water, involuntarily dirty the clothes. A little later, profuse vomiting also of the same rice-water variety, appears along with excruciating cramps in the abdomen and the calf-muscles of the leg. The victim rapidly passes into a state of collapse, looking like the ghost of his normal self. His nose stands out thin and pinched above sunken eyes and hollow cheeks. The skin of his fingers becomes loose and shrivelled like that of a washerman fresh from a long day's work at the washing-ghat. His voice becomes husky, hollow, hushed to a whisper, and his body cold, bedewed with a clammy sweat. The weak pulse flutters, and then disappears; the body temperature sinks below the normal, but rises in the rectum to 105°F.

Suppression of the urine makes him toss from side to side. He throws out his arms to clutch at the fast ebbing life, complaining of a tight feeling in the chest. He asks for something cool to quench his inordinate thirst. The victim soon breathes his last—at any time within the span of two to thirty hours.

Doctors are intrigued. It is fatal to the very young and to the very old. It kills patients suffering from kidney, liver, or heart complications. The feeble, the undernourished and the dissipated collapse before its onslaught as a house of cards before a strong gust of wind. Pregnant women are not respected; they too are gathered to the cemetery without the least hesitation. Is it just severe diarrhœa, or can it be mushroom or ptomaine poisoning? The symptoms even resemble pernicious malarial fever. But it is none of these.

All that the suffering people know of this epidemic is that it is imported from the little known lands of Asia. How it has come, by what route, across sea and land, is baffling the scientists of Europe. The ships travel faster than before; travel over land is easier and speedier, too. Evidently that has made it possible for the epidemic from the Far East to invade distant France. Just possible.

Then comes more reliable news. From the heart of Bengal, the scourge is known to have swept along the Indo-Gangetic Plain, triumphantly marching into Afghanistan and Iran, stamping into Russia

by way of the Caspian Sea and the Volga Valley, enters Europe, taking the Balkan countries in a single stride In two years' time, it penetrates the customs barriers of England, Canada, and the USA, and has made a huge harvest of the Anglo Saxon race

For long years, the scourge holds undisputed sway Then, without notice, quite suddenly, cholera disappears from Europe, not by the conscious efforts of man, but as if by magic But cholera continues to be prevalent in its 'homeland'—in Calcutta, Bangkok, Canton and Shanghai—though the rest of the world has become free after its baptism by death

1848, the year of revolution in Europe, witnesses a strong tide of annihilation with wave after wave of cholera for three years

Just as the tide is ebbing, another wave engulfs the continent for five years From 1855 to 1865 there is respite Then again cholera takes its toll, this time for another ten long years 1884 and 1892 witness its recrudescence once again, but from now onwards, its activity is circumscribed In 1913, during the Balkan War, cholera puts in an appearance, but is immediately quarantined and stamped out Since that day, Europe has not suffered from a cholera epidemic on any major scale

Every time cholera conquers Europe, the invasion does not follow the same route From the Persian Gulf into Syria, then Asia Minor and Turkey, across the Bosphorus—that is one route, sailing up the Red Sea, sweeping the Arabian Peninsula on the one hand, and sliding into the fertile Nile Valley on the other, making a halt in Cairo, and then jumping across the Mediterranean into Europe—that is yet another These are the great routes of trade and commerce and conquest of the East by the West, the routes along which gold and raw materials from India and China are looted by the European marauders Cholera is the unwitting gift which comes to the West along with the ill gotten spoils of the East

Men of science begin to study the epidemic waves of cholera as they sweep the hinterlands of Europe six times in half a century They observe that man is undoubtedly the carrier of the disease They find that sea ports and the landing places are always the first spots to be affected They notice that pilgrim centres like Benares, Gaya Hardwar, Mecca, Medina, Jerusalem are the great market places of cholera Here the disease drinks its fill of human blood, and from here start the long trails of returning pilgrims who infect country after country that they pass through on their way home The victims rest on the river banks, and there is cholera They wash soiled clothes

at wayside wells, and there is cholera. They live in roughly-improvised, crowded, unhygienic hutments, and there is cholera once again. A single cholera carrier is more formidable than the hosts of Ghengiz Khan or Mahmoud of Ghazni. Irrespective of sex or age, the long sword of death mows down thousands—helpless impotent masses of frightened humanity—who have not even energy to stand together in their death pangs.

And all this time, the real assassin remains undetected. Human ingenuity is at its wits' end to locate the source of this menace to mankind. Many guesses are made. Some declare that it is Almighty God's righteous anger—the hand of 'fate'—for the political sins of the rebels. Others vehemently disagree, and explain that developments in the solar system—the sun-spots and the comets—are responsible for a cosmic disturbance, and this in its turn is responsible for the disease. Still others say that cholera is an infectious disease, just like any other disease, and the contagion passes from man to man by physical contact.

No one can rest in peace. It is impossible to be complacent in face of the danger that hides behind the cloak of night. Every fresh gust of the cholera epidemic brings with it echoes of the wails of tortured and dying, innocent human beings.

Many a lonely watch-dog of science intently keeps vigil all through the night of the nineteenth century; the passing shadows of cholera epidemics are chased by shrill cries which are picked up from one street to another in the desolate cities of Europe. There is a small school of scientists who observe the prolific rice-water stools of the victims, and feel that fermentation in that decoction is in some mysterious way connected with the spread of the disease.

In the month of August 1854, London is in the grip of the epidemic. A child dies of the disease in four days after a gruesome struggle with stomach cramps. That is the signal for a massacre of the innocents to begin in the whole district. Dr John Snow investigates the epidemic in Broad Street. He traces the stools of the child victim to a cesspool which is leaky; it connects with a well three feet away. On the last day of August, most of the persons who have drunk water from the contaminated well are caught in the murderous grip of cholera. Two days later a woman dies of cholera in another locality —Hampstead—which is not affected by the epidemic so far. She liked the waters of this Broad Street well, and not only drank it herself, but gave it to a niece who was visiting her on that fateful day. The bier of the niece follows that of the aunt to the cemetery. A

servant who also drank the water escapes death after a harrowing struggle with the disease.

Dr Snow concludes: 'The inference that the germ of cholera is conveyed through the polluted water of the Broad Street Well, is difficult to rebut ... I believe that this germ emanates from the excreta of the patient or the patient's soiled linen, and reaching the Broad Street Well, is transferred to the mouth nf the epidemic victims ... Even flies must have played some part in reaching the food of the victims.'

Dr Snow's observations are soon forgotten when the epidemic wanes.

South London furnishes another link in the chain of evidence which points to water as the infective agent. In 1854 there are two companies that supply water to London—the S. & V. Company, and the Lambeth Company. Both depend on the River Thames for supplies. The Lambeth moves its source of supply higher up the Thames after the last cholera epidemic in 1848. The S. & V. Company remains where it is. During the 1854 epidemic, it is observed that the cholera mortality is 153 in houses receiving water from S. & V. supplies, as against 26 in houses catered for by the Lambeth Company. The river is evidently contaminated at the spot where the S. & V. draws its water.

Science now makes another conclusion—cholera is a water-borne disease, and it attacks human beings by entering their stomachs. The circuit of the disease is traced by Macnamara, a shrewd scientific observer. The rice-water stools from a cholera patient are thrnwn in a pool of water which remains exposed to the burning heat of a clear sun for a whole day. Next morning quite unintentionally, nineteen persons are given the contaminated water to drink. The quantity taken is small, about an ounce only. Yet five out of the nineteen writhe in death agonies of cholera within thirty-six hours. Macnamara concludes: The cholera germ multiplies inside the stomach of the victim and ultimately passes out in his stools. When the stools get an opportunity to contaminate drinking water, the germs multiply again, and start the circuit of death through the stomach of another victim.

Twenty-nine years later, in the year 1883, when cholera wipes out human lives in Egypt, and threatens to break through the portals of Europe, Koch comes on the scene, and he sets out on the trail of this new mysterious enemy of mankind.

A strange rivalry now commences between Pasteur, the Frenchman and Koch, the German. They both compete for the germ of cholera,

Koch, with his companion Gaffy, arrives in Egypt and installs himself in an ill-equipped, ill-ventilated laboratory. Both toil without respite in the sweltering heat of Alexandria, dissecting endlessly the carcasses of cholera victims. Pasteur is at this time absorbed in his researches on hydrophobia. His patriotism feels ill at ease that the field of cholera should be left open for conquest by the German. So he sends his two able assistants, Emile Roux and young Thuillier to Egypt. Whilst the two rival groups are immersed in looking through their microscopes, just as they are about to put their finger on the murderer, it seems the irony of fate that the culprit begins to slip away from between their fingers. Without any visible indication the epidemic dies away.

Deeply disappointed after having miserably failed in his mission, Koch is preparing to leave for his homeland, when in rushes a messenger and informs him of the sad death of the youngest, most promising scientist of the day, Thuillier—his rival. The hunted has turned round and killed one of the hunters: Thuillier has died of cholera. The scientist in Koch puts aside all differences, and he hastily rushes to Emile Roux to offer him his sincere condolences. He places wreaths on the grave of the young microbe-hunter: 'The wreaths are very simple; but they are of laurel, such as are given to the brave.'

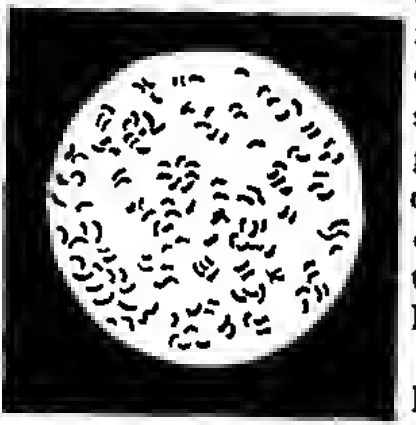
Now Koch hurries to Berlin from Alexandria, hugging tightly his boxes laden with hundreds of specimens. He unpacks the specimens, heavily stained with powerful dyes, and commences a tireless search with the aid of the microscope. In each specimen he finds the same microbe—curved and comma-shaped. Koch approaches the Minister of State in order to secure permission to proceed to India—the home of cholera epidemics. Irrespective of the tragedy that has overtaken young Thuillier, Koch is unafraid and sails for India.

Koch's only friends on board the ship throughout the journey, the confidants of his secret thoughts, are the mice and the guinea pigs he is carrying with him for varied tests in India. The other passengers do not interest him.

He lands in Calcutta, where the epidemic is raging, and finds the same comma-shaped bacilli in hundreds of carcasses of cholera victims which he dissects.

Koch is now convinced that he has traced the murderer. But his scientific conscience will not accept the conclusion until he has raised pure cultures of comma microbes on beef-broth jelly. Koch closely studies their birth, their death, the congenial surroundings they prefer and the way they die. There is no doubt left. It is the comma bacillus

that infects healthy people through the soiled linen of cholera victims or through polluted waters of tanks and rivers. After reaching Berlin he submits his report: 'Cholera never rises spontaneously. No healthy man can ever be attacked by cholera unless he swallows the comma microbe, and this germ can only develop from its like; it cannot be produced from any other thing, or out of nothing. It is only in the intestines of man, or in highly polluted waters, like those in India, that it can grow.'



Cholera bacilli

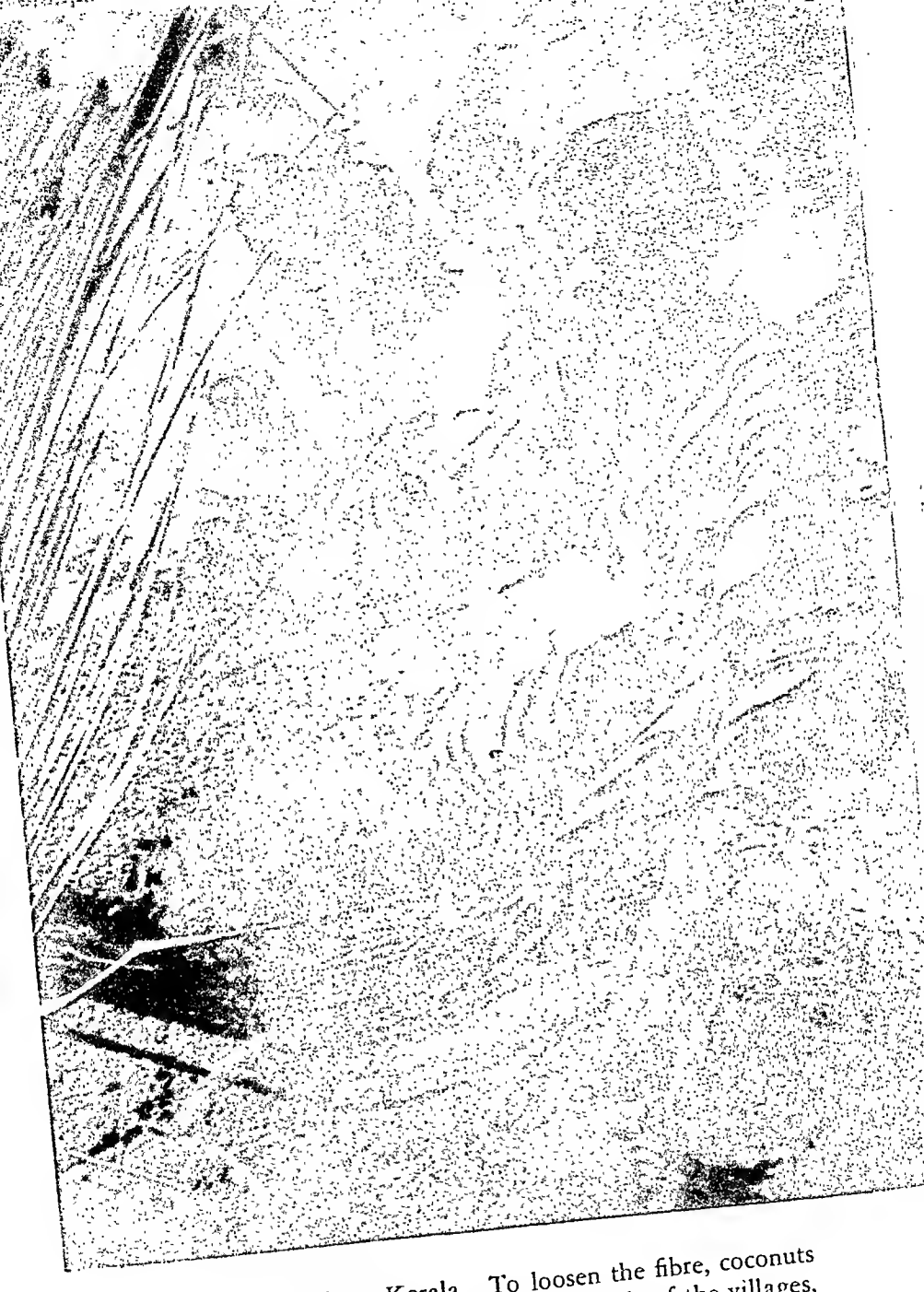
The scientific world of Germany is jubilant over Koch's fresh success. The German Emperor bestows on him the highest emblem of honour by decorating him with the Order of the Crown. Koch is modesty personified. He replies: 'I have laboured as hard as was permitted to me. If my success has been more apparent than that of others, the reason is that I came upon regions where gold was still lying by the wayside during my wandering in the fields of medical science. That is luck, and no great merit on my part.'

Now Koch feels bold enough to assert one deduction—the absence of the comma bacilli in a stool is a trustworthy indication for declaring it non-choleraic. He has found the bacilli in the stools of only cholera patients.

What does this comma bacillus look like? It is a very tiny microbe, half the length of the tubercle bacillus. It is curved like a comma. It has peculiar habits. It detests distilled water; but thrives in salt water. In milk it multiplies at an enormous rate. But milk does not curdle because of the comma bacillus.

Post-mortem examination of cholera victims shows marked effects produced by the disease. The lungs become dry, shrunken and anaemic. The pulmonary arteries distend with blood; the pulmonary veins are empty. The liver gets loaded with blood; the spleen becomes small and shrivelled; the gall bladder is saturated with bile. Inside the bowels can be found a large quantity of the rice-water liquid seething with comma bacilli.

After Koch has published his discovery, there arises a great controversy: Is the comma bacillus the germ of cholera? Everybody concedes that it has an intimate connexion with the disease, but many scientists refuse to accept it as the only cause of cholera.



Coir workers, Kerala. To loosen the fibre, coconuts are left to rot in the pools and canals of the villages, turning them into slow black pools of rank filth. The women sit beside these pools and beat out the fibres, earning a few annas a day for their toil

Flies swarming on the face and body of a child in a peasant hut in a village near Mayasandra Mysore State

In our society we come across cynics. There is Professor Pettenkofer who lives in Munich. He believes that the disease arises in the soil from chemical fermentation, the cause of which is accidental and unknown. He openly scoffs at Koch's latest discovery. He challenges Koch to send him his most virulent comma germs. Koch sends him one tube. Pettenkofer, without a moment's hesitation, swallows the whole of it. The contents of that one tube are enough to wipe out a whole city. If Koch's theory is infallible, there is certain death—an agonising painful death—in store for Pettenkofer. Strangely enough, Pettenkofer survives. Nothing grave happens to him. It is inexplicable; he escapes with minor stomach ailments. He growls loudly at Koch: 'Germs are of no account in cholera. It is the disposition of the individual that matters. You see I am alive in spite of your poisonous germs!' And he mumbles something about spinning test-tube yarns.

Pettenkofer

Scientific searchers have wrangled for a long time about this Pettenkofer miracle. Nobody yet has been able to solve the puzzle as to how Pettenkofer escaped death. Koch has been proved correct in his discovery that in every known cholera case, the comma bacillus has been found without fail. Other men have swallowed cholera cultures by accident and died an excruciating death. Then wherein lay the immunity of Pettenkofer? Science so far has not found a convincing answer.

Metchnikoff, a scientist of renown, swallows a pure culture of the cholera vibrio. While he mocks at the ravages of disease, suddenly death peeps inside his laboratory, and in the twinkling of an eye, he is lying by the side of his ancestors in his grave. The followers of Koch rejoice because their pet theory has been proved correct.

Buchner, another scientist of established reputation, supplies a plausible explanation of the erratic behaviour of the comma bacillus. He suggests that probably some second, and as yet unknown, microbe —too tiny to have been spotted so far—must accompany the cholera

vibrio in order to cause the disease in its virulent form Repeated experiments now show that the comma bacillus varies in its virulence without notice and without an ostensible cause The comma bacillus is a mystery *par excellence* for the scientist, because it has been known to vary its intensity as high as one to five hundred!

Metchnikoff

Microbe hunters armed with their powerful microscopes sit down in their laboratories and do some close thinking They realize that the human body is a much more complex affair than they were led to believe at first The human body is not the same thing as an arithmetical equation One plus one is not always two in the problem of disease, it sometimes remains only one, probably with some slight battering In human affairs, the cholera vibrio plus the man is not always equivalent to a cholera victim

The conditions which make for the spread of infection of a cholera epidemic are *evidently complex* Koch himself realizes this when he is sweating to conquer cholera in 1892 He searches high and low for the man who brings cholera to one European city after another There are occasions, when he does not find him among the people who actually suffer from cholera Then how did the bacillus go out in the excreta and pollute the water? After careful investigations, Koch finds that the bacilli of cholera can be carried by persons who may not themselves be suffering from the disease, but who are 'carriers' of the disease

At this time occurs the Hamburg epidemic of 1892 Hamburg and Altona are sister cities, and differ only in the matter of their water supply Hamburg and Altona receive their drinking water from the heavily infected Elbe River, but with this difference that while Hamburg does not care to purify or filter its water, Altona carefully filters it before passing it down the pipes The Elbe is especially polluted at the time when the epidemic breaks out A large number of Russian emigrants are housed on one of the wharves They come from cholera infested areas They use the river for discharging their excreta as well as washing their dirty linen The epidemic claims 8,605 lives in Hamburg as against only 328 in Altona The latter

are evidently people who drank the Hamburg water. The most significant fact noticed is in one place where the boundary between Hamburg and Altona is a common street, with Hamburg houses facing the Altona houses across it. There are heavy casualties on the Hamburg side of the street, and none on the Altona side. In Hamburg itself there are groups of houses which escape cholera. On investigation it is found that they get their water-supply from Altona pipes.

Cholera Pie
Caricature by Cruikshank suggesting that doctors thrive on cholera

It is interesting to remember that the Hamburg water-supply is taken from a point upstream from the city. But the fact that is forgotten is that the river is tidal, and the sewage of the city is carried upstream with the rising tide. Thus, Hamburg is infected through the Russian emigrants who are mostly carriers, and not cholera patients.

Altona actually takes its water-supply at a point down-stream from Hamburg. It thus receives water more highly polluted than the Hamburg water-supply base. The saving grace of Altona is the sand-filters it uses. But for this Altona would have been ravaged much more fiercely than Hamburg.

Every European city worth the name now provides for filtration of its water supply. Elaborate care of sewage disposal and protection of drinking and washing water, have become the first concern of every community which wishes to escape death from cholera epidemics.

This is the history of the cholera vibrio.

Yours affectionately,
MASHI

LETTER XV

LINA AND VIJAY,

In this letter I propose to tell you how cholera can be conquered and eliminated from our country. The number of deaths every year from cholera is never less than a hundred thousand and often rises to half a million. In 1943, in Madras Province alone, there are 117,039 deaths due to cholera. The incidence of the disease varies from year to year in a surprising swing. In the same Madras Province, deaths from cholera are only 2,115 in 1939.

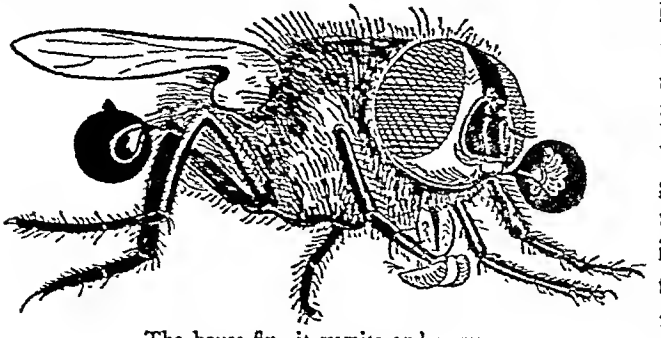
One of the largest cholera epidemics in recent years begins at the Hardwar festival in April 1938, and then engulfs the Punjab, Delhi, United Provinces, Bihar and Central Provinces—more than half of India. Scientists have found out that the *endemic foci* of our country are located in Bengal for the north, and the Cauvery Delta for the south. The pilgrim centres are certainly the danger-spots.

The first thing to remember is that cholera spreads through the discharges of a cholera victim—his stools and his vomits. Cholera is known as the 'filth disease'. The excreta of a patient must reach the mouth of other human beings in order to give disease. Scientists have found the cholera vibrio alive even after fifty days in stools of victims who have recovered from the disease. The germ dies in a few hours if dried, but it remains healthy and vigorous for many days if kept in congenial moist surroundings, such as damp, infected clothing or wet soil.

From this arises the first warning: All clothing of cholera patients must he immediately disinfected or destroyed

The next thing to remember is that cholera germs enter the body of a victim through the mouth, along with the water he drinks or the food he eats. From this arises the second warning: every precaution must be taken to prevent contamination of wells, public water supplies, drinking and eating vessels and all kinds of food. Sewers and cesspools must not be allowed to connect with lakes, ponds and wells which supply drinking water. Rivers and reservoirs must be guarded from pollution by possible cholera carriers. The fly, the cockroach and other vermin must be prevented from squatting on eatables. Every cholera victim and cholera carrier must be effectively isolated and quarantined for the incubation period of a week. You will now realize why it is an offence against the laws of stable society to dirty the waters of the lakes from which the city receives its water supply. It will he apparent to you why the municipality enforces regulations

compulsorily on sweetmeat sellers and food-vendors to cover their attractive eatables with nets and glass cases. This is because flies must be prevented from giving us cholera. It is easy to see why passengers on boats trying to land in other countries are sometimes quarantined so that the last suspicion about disease-carriers can be attended to by an efficient medical staff. For the same reason our tap-water becomes pinkish and tastes peculiar, whenever danger from cholera is apprehended. The municipality chlorinates the water and neutralizes it against possible germs by adding potassium permanganate to it.



The house-fly—it vomits and purges and pollutes wherever it sits

Whenever you hear that cholera is raging in your city or village, it is of the utmost importance to exercise great care to preserve your general health. You must avoid excess in foods and drinks, excess in fatigue and work, excess in exposure to chill. Fruits or vegetables which are either over-ripe or raw are equally dangerous. Food which is in a state of decomposition, shell-fish, melons and cucumbers are especially harmful and must be avoided. Drinking water, and water for washing plates and dishes, should be boiled. Milk will need pasteurisation. The cook must wash his dirty hands with soap before he enters the kitchen. Purgatives must be given up for the time being and the slightest sign of diarrhoea should be promptly reported to the doctor.

All this you can do on your own. But there are things which a medical man alone can do for you. He can give you temporary immunity against the disease by anti-cholera inoculations. You must know the history of these inoculations.

In 1885 Spain is ravaged by a cholera epidemic. Ferran is the first scientist to introduce prophylactic inoculation. He injects pure cultures of the cholera vibrio which he obtains from cholera corpses. On the principle that poison is the best antidote for poison, he often succeeds. But he is not able to cure every time. He does not control the virulence of the cultures he uses for his injections.

In 1893 Haffkine improves on Ferran by using a pure virus of a fixed and known strength In 1895, with the active support of the Government of India, he tries his mild vaccine on nearly fifty thousand individuals Haffkine claims that the results are encouraging The microbes he injects soon die inside the body of the patient, at the same time releasing substances on their death which give immunity against cholera Compulsory inoculation for cholera is now enforced on all pilgrims visiting festival centres

How will you treat a cholera case if you are placed in charge of an epidemic centre? Your first efforts will be to control and counteract the diarrhoea which normally precedes the main attack of cholera After that your efforts must be concentrated on helping the victim to preserve his energy to fight the disease

The patient must be kept in a warm bed, in a well ventilated room Sips of iced water or soda water can be given to quench his thirst The body must be kept dry, and when the patient feels cold, hot water bottles can be applied The patient must not be allowed to get up on any pretext, even for stools a warmed bed pan must be used Food of every kind must be withheld whilst the attack lasts

Now the doctor can come and help the patient to fortify himself against the dehydration of the blood caused by the constant stools and vomits Injections of saline solutions are found to be very effective by Sir Leonard Rogers, an eminent cholera expert

That is all that can be done Science supplies a negative remedy against cholera It prescribes preventive measures but no effective antidote against the really virulent type of cholera vibrio So far, the quarantine regulations and the care of water and food it prescribes have given complete protection against cholera epidemics in two continents, Europe and America

It is interesting to read about 'remedies' that have been attempted by doctors against cholera about fifty years ago, and now universally discarded I copy it from a medical book of the last century The list is imposing 'Bleeding, cupping, blisters, emetics, purgative enemata astringent and opiate enemata, injections of warm water, inhalation of oxygen gas, of nitrous oxide, sulphur, sulphuric acid, nitric acid, nitrohydrochloric acid quinine ipecacuanha, Indian hemp, belladona, atropine injections, morphia, camphor and turpentine injections brandy, cajupet oil, castor oil croton oil, creosote, carbolic acid chloroform nitrite of amyl charcoal, ether, sugar arsenic sulphate of copper, calomel, acetate of lead, logwood nitrate of silver, petroleum, phosphorus, sumbul, turpentine wet sheet packing cold

affusion alternated by hot baths; hot air baths; vapour baths; mustard baths; ice to spine; cautery along spinal column; vesication with boiling water; acupuncture of heart.'

What a lot of groping in the dark that means!

To conquer cholera, all that our country needs is effective measures of sanitation and hygiene. Do you realize how necessary it is to form clean habits in order that our country achieves perfect health, a first condition for securing a place in the comity of progressive nations?

Yours affectionately,
MASHI

LETTER XVI

THE UGLY MINISTER OF DEATH: SMALLPOX

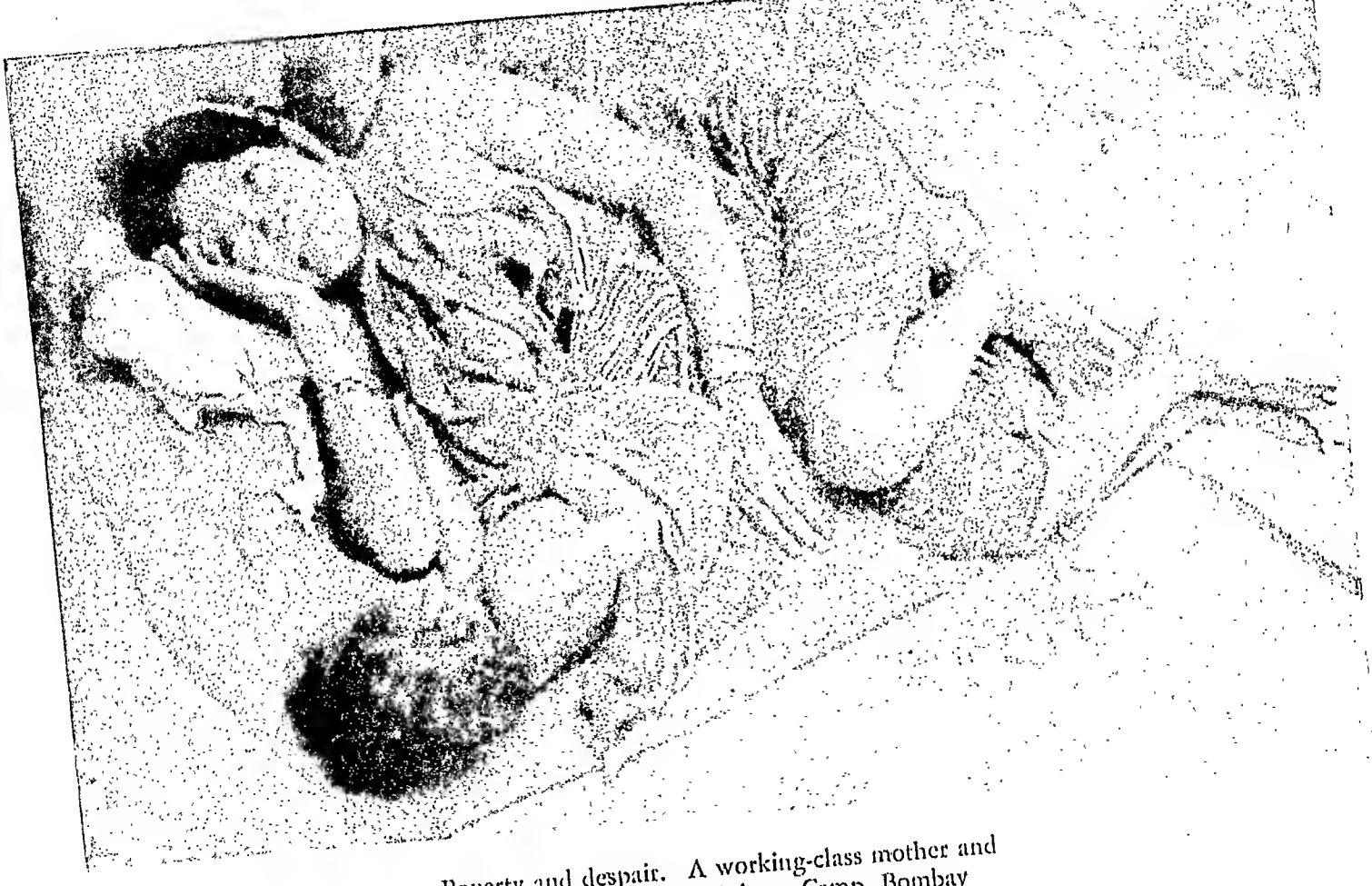
LINA AND VIJAY,

I do not know if you are aware of the terror the word 'smallpox' evokes in me. I go in horror of the disease as a child goes in horror of the cane of an impatient and heartless teacher. This deep-seated inhibition has a history, and I shall relate it to you.

Have you ever been engulfed in a thick fog on a pitch dark night? I was once caught in a fog in the northern hills. I could not see even a yard ahead of me. The air was still; not a leaf stirred; my quiet breathing was the loudest sound for miles around And then I heard footsteps—heavy, laden with the burden of a palpitating heart and an inflamed mind. Louder and louder they thumped nearer. Here was a single human being, but he seemed to stamp his footprints in the dense fog, thumping his leaden feet on that cold, hard, invisible world. He was alone, in a hurry to get out of the fog. I sat in my hidden corner and wondered: What makes him clutch at sound as a drowning man catches at a straw? The answer came to me as the steps thumped their way into obscurity: he was a lonely man, but he had filled the desert around him with the monsters of his imagination. It was fear—fear of the unknown—fear of pain—fear of death—that was clutching at his heart. I have known that fear in connexion with smallpox.

It begins when I am a child. The word smallpox brings back to me vividly an incident of my childhood.

It is a hot steamy day in the month of April. I am relating an imaginary story to my sister, and we are both deeply engrossed in its meshes. Suddenly my tongue falters; my eyes have dammed the flow of the story in the abyss of the pock-marks on my sister's face. For the first time, I notice the ugly dents on her cheeks. I gaze intently—gaze with horror. My sister does not understand my sudden silence. The child in me bursts out, without the slightest consideration for her feelings: 'How did you get these ugly marks on your face? They spoil your looks!' 'Of course, how can you know or remember that I incurred the wrath of Shitala Mata—the Goddess of Smallpox? That is the penalty for sins committed by me in a previous life,' is her answer.



Poverty and despair. A working-class mother and child in the Matunga Labour Camp, Bombay

What is their future? A destitute family in the Kashmir Valley

This piece of news frightens me. Inwardly I begin to pray to the make-believe goddess not to visit her wrath on me.

Let me recount to you the fascinating history of the heroic struggle man has waged to combat and conquer this deadly scourge.

Smallpox exists in the East from times immemorial. Evidence of the dismal legacy which smallpox leaves behind is available to us on the faces of the Egyptian mummies entombed three thousand years ago in the Pyramids. In the tenth century, Europe for the first time itches under its sting. In another five hundred years, there is not a corner of Europe which is not contaminated. America is so far free from this horrible and ugly pest. But with the infiltration of the Spaniards into Mexico in the sixteenth century, America too is polluted. Three and a half million people die from it. The American Indians are reduced to half their number. The Pilgrim Fathers, who arrive in the 'May-Flower', in the words of Cotton Mather, voice their satisfaction at this decimation: 'The woods are almost clear of these pernicious creatures, to make room for a better growth.' However, this unholy satisfaction is short-lived. Even the newcomers are not safe from smallpox. In Boston alone six waves of epidemic in quick succession sweep away thousands. The cause of the last epidemic is traced to a patient aboard 'The Sea Horse', arriving from the Barbados. Boston loses half of its population in this catastrophe.

Smallpox patient
—Naples bust

In Europe itself, inoculation is introduced by a strange coincidence. In the beginning of the eighteenth century, Lord Montague is posted as the British Ambassador to Turkey. His wife is of a social temperament, moves about in society and intelligently observes Turkish customs. In the year 1717, Lady Montague writes to a friend about 'ingrafting', widely utilized in Turkey to secure immunity from the fatal disease: 'I am going to tell you a thing that I imagine will make you wish yourself here. The smallpox, so fatal and general amongst us, is entirely harmless by the invention of ingrafting, which is the term they give it. There is a set of old women who make it their business to perform the operation every autumn in the month of September,

when the great heat has abated. People send to one another to know if any of their families have a mind to have smallpox. They make parties for this purp when they meet (common to sixteen together) the ol comes with a nutshell full o of the best sort of smallpox and asks what vein you please to have opened. She immediately rips open that which you offer to her with a large needle (which gives you no more pain than a common scratch), and puts into the vein as much venom as can lie upon the end of a needle; and after, binds up the little wound with a hollow bit of shell, and in this manner opens four or five veins. The children or young patients play together all the rest of the day, and are in perfect health until the eighth day; then fever seizes them and they keep their beds two days, very seldom three. They have rarely about twenty or thirty [pocks] on their faces which never mark, and in eight days' time they are as well as before their illness. Everywhere thousands undergo this operation, and the French Ambassador says pleasantly that they take the smallpox here by way of diversion, as they take the waters in other countries. There is no example of anyone who had died in it, and you may well believe I am satisfied of the safety of the experiment, since I intend to try it upon my dear little son. I am patriotic to take pains to bring this useful invention into fashion in England'

Lady Mary Montague

Lady Montague is a woman of conviction, with a deportment as soft as the glow of a candle, but with opinions as hard as cooled lava. On her return to England, she introduces inoculation and is abused and ill-treated for her pains. Instead of reward and thanks, she is persecuted. The faculty of medicine raises violent protests, calls the method barbaric and predicts dire results. The Church looks upon it as an act of disloyalty to the Almighty, 'seeking to take events out of the hands of Providence'.

The idea that one has to 'take' smallpox gratuitously, raises bogies in the minds of many. Why take poison unnecessarily? After all,

it is a hypothetical thing that you will be the future victim of the disease. Why invite the disease now, when God himself has spared you so far?

The question of subsequent immunity is also doubtful. There are cases when inoculation has brought on a terrible attack. It is argued: a bird in the hand is worth two in the bush; you have good health today, do not run after hypothetical things and endanger it. You must preserve your health and not jeopardise it in the wake of new-fangled reformers.

But the horror of smallpox is great. Ben Jonson has voiced it:

> Envious and foul disease, could there not be
> One beauty in an age, and free from thee?

I am reminded of a quotation from Macaulay. He describes smallpox in England: 'That disease over which science has since achieved a succession of glorious and beneficent victories, was the most terrible of all the ministers of death. The havoc of the plague had been far more rapid; but plague has visited our shores only once or twice within living memory; and smallpox was always present filling the churchyard with corpses, tormenting with constant fear all whom it had not yet stricken, leaving on those whose lives were spared the hideous traces of its power, turning the babe into a changeling at which the mother shuddered, making the eyes and cheeks of the betrothed maiden objects of horror to the lover.' So, there is a good future for whosoever can rid the land of smallpox, in spite of the terror of inoculation.

At her wits' end, Lady Montague sits down to think out a way of convincing the populace about the absence of danger from inoculation. She approaches the Court on behalf of seven criminals sentenced to death, and locked up in the Newgate Prison. They are to be permitted to escape the gallows, if they volunteer to be inoculated under the aegis of Lady Mary. The Court grants the plea, and three eminent medical men shoulder their lancets, and 'give' smallpox to these criminals. Six are inoculated in the Turkish way; the seventh is made to take smallpox in the Chinese way by putting dried crusts of smallpox in his nostrils. All develop the disease in a mild attenuated form. The man on whom the Chinese method has been tried, suffers in addition from severe headaches.

Lady Mary has won. The Newgate experiment creates a sensation. Inoculation has come to stay in England. And just as well,

Nearly two-thirds of the inmates of the London Asylum for the Indigent Blind are cases resulting from smallpox.

Lady Montague is not alone in her weary vigil in the fight against smallpox. Cotton Mather shares her fate in America. He earns vulgar abuse in return for the knowledge of immunity which he tries to spread.

Another lone campaigner is Dr Bolyston of Boston. He inoculates his only son against smallpox in the year 1721, the first human being to be inoculated in America. The opposition against inoculation is widespread, and Bolyston is not left in peace by his countrymen. They pile hot coals on his head, and call his action 'a presumptuous interference with God and Nature'. They shun him as a heretic. Oliver Wendell Holmes records: 'Bolyston was mobbed, and Mather had a hand-grenade thrown in at his window.'

Thomas Dimsdale

You have certainly read in your history books about the fierce and unreasoning opposition conservative men always offer to the infiltration of a new idea in society. So also it is in the realm of disease. The new 'cure' creates as much fear as the disease produces horror.

A new medical discovery is like a lighthouse on a rocky sea-coast with the incoming tide of humanity beating against it, seeking to tear it down, drowning it in the hope of destroying it. But the tide which is so vehement abates, and the lighthouse continues to stand out proudly at ebb tide, dominating the waters of the sea, calmly guiding the ships to safety. Inoculation was sought to be engulfed and destroyed by the force of invective of a fear-ridden, maddened populace. When the tide of rage abates, inoculation is accepted as a landmark which is guiding mankind to avoid the rocks on which shipwrecks are so constant.

Inoculators are coming into fashion. Inoculation is performed in France in 1717, and becomes the vogue in a period of five years. Germany welcomes it at the hands of Dr Maitland in 1724. The Scandinavian lands, Holland, Switzerland, Italy, Spain are not far behind. Thomas Dimsdale of England builds up a great name as one

of the most successful of the new fraternity of inoculators. The fame of Dimsdale spreads all over Europe. He is invited by Catherine the

Cartoon of vaccination
—*Anti-Vaccination Society*, 1909

Great of Russia to rescue her horribly-tortured subjects. There is danger involved. Count Parrin, the Prime Minister of Russia, sidles up to him and whispers through clenched teeth: 'To your skill and integrity will probably be submitted no less than the precious lives of two of the greatest personages in Europe.' As much as to say, your own life is forfeit if anything ominous happens to the Empress or the Grand Duke, her son. But Catherine has full faith in his skill. Catherine makes arrangements for relays of post-horses from her St Petersburg Palace to the borders of Russia, to provide for the doctor's flight in case the experiment proves fatal. The experiment of inoculation is a success for the Empress and her court.

The work of inoculation in Russia does not spread fast enough in that huge sluggish continent of the days of the Czars. In 1771 Moscow is visited by a violent epidemic. Masses of suffering humanity gather at the shrines of the Virgin to seek divine intercession. The gathering of infected and non-infected further helps to spread the disease. The Bishop of Moscow closes the shrines for public worship. An enraged populace bursts into his palace, chases him into the cellar and kills him in its frenzy. One fact stands out very clearly. All who were inoculated by Dimsdale remain safe against smallpox. Inoculation furnishes its most objective proof.

And yet there is risk involved in inoculation. The mild smallpox that it gives, sometimes proves fatal. There is a possibility of passing on syphilis and other infectious diseases along with the matter from the pocks of the patient. And finally, those inoculated do get real smallpox, however mild, and become the focal point for the spread of the disease to those not inoculated.

Benjamin Jesty

In England it is a commonly accepted belief amongst farmers that dairymaids who contract cow-pox from the cows they milk, are safe from smallpox. The beautiful mistress of Charles II, the Duchess of Cleveland, gives expression to this belief in open Court when a jealous courtier tries to predict that her beautiful face will be marred by smallpox, and Charles is bound to abandon her. She turns round and tells him: 'I have already been through cow-pox. Your wish is futile.'

Some popular beliefs are empirically correct So is this Cow-pox is the disease that brings about an eruption of pustules on the udders of cows. In horses, the eruption appears on the heels, and is known as the 'grease'. Both belong to the same family as smallpox. A new line of approach is suggested by the knowledge of the dairymaid and the farmer. Inoculation is to give way before vaccination. The purulent matter does not have to come from a smallpox patient, hut from the lymph of a cow.

In 1774, a blunt honest farmer scratches his head, nods his slow-moving brain-box, and decides to put the belief into practice. Benjamin Jesty is a Dorsetshire yeoman with no pretensions to he a medical man He is the first to infect cow-pox matter under the skin on the arms of his wife and two sons. The two sons escape with a mild attack; Mrs Jesty hovers between life and death. Her precarious condition alarms the countryfolk for miles around and creates hostility towards vaccination. People refuse to be subjected to this 'inhuman' method. They begin to despise Jesty for his 'morbid trick' and 'indulgence in filth', as they despise the dirt in the gutters outside their homes.

Nemesis is however round the corner. The messiah to rid the

western world of smallpox is already twenty-five years old, and is aspiring to become a medical man. Edward Jenner is the proud son of a discreet clergyman from Gloucestershire. He has a good education and studies under the able surgeon and investigator, John Hunter. The relations between the teacher and the pupil are cordial and intimate. But Jenner betrays no sign in his youth of the great name he is to carve out in the annals of medical history. He writes an ode 'To a Tom-tit' and other third-rate doggerels, and is for all intents and purposes a third-rate medical practitioner. He is blonde and blue-eyed, loves to play the flute and the violin, and his hobby is to hunt birds with delightfully coloured plumage. During one of his favourite riding jaunts, Jenner unburdens his soul to a friend in the following strain: 'Edward Gardener, I want you to listen to me. I have a hunch that smallpox is contracted in this wise: a farmhand is treating the 'grease' on the heels of a horse. Then perhaps he milks a cow. The cow gets cow-pox on the nipples where the hands of the farrier had brought infection from the heels of the horse. Another morning, and the dairymaid swings along, pail in hand, to milk the cow. She thinks nothing of the inflammation on the udders, plies her active fingers, and gets cow-pox on her hand. The dairymaid is pretty and attractive. She has several young swains in the village who seek to hold her hand in the gathering dusk of the evenings. So goes the tell-tale disease round and round the village, from hand to face, and face to face. But the venom of the disease is mitigated. The horse is never suspect, nor is the cow. And once they have had cow-pox, the farmhand, the dairymaid and her lovers, are safe when smallpox epidemic collects its death toll at a later period. I wonder if I am right. I have entrusted a most important matter to you, which I firmly believe will prove of essential benefit to the human race.'

Edward Jenner

Jenner is an unsophisticated medical man, ready to learn from the observations of dairymaids and farriers. He writes to his teacher, Dr Hunter, and poses the problem. Hunter replies in words which have become classic for all students of experimental science: 'Don't think; try. Be patient, be accurate.'

Twenty-two years after the daring experiment of Jesty, in May 1796, Jenner performs his historic vaccination. This is the story of how a small brave boy helps science, in company with an ignorant dairymaid The dairymaid, Sarah Nelmes, has cowpox eruptions on her wrist, forefinger and base of thumb. James Phipps is the small boy who 'takes' smallpox from the pustules on the hand of Sarah, with Jenner acting as the inoculator. We have a painting by Gaston Melingue of the incident. James Phipps develops a mild attack and soon recovers.

The hand of Sarah Nelmes

Jenner's contribution to science is not the act of vaccinating James Phipps; it is the essential scientific approach he brings to bear on the problem which is important. A month and a half later, Jenner tests the immunity of the boy by inoculating him directly from a smallpox patient. The boy stands the ordeal without harm Some months later, James Phipps is again tortured with fresh inoculation Once again the boy Phipps stands his ground.

Now Jenner multiplies his experiments over and over again with fresh candidates. The result tallies in every case. Then Jenner announces his discovery to the world. He claims from established facts that the first vaccination from cow-pox has definitely given safety against any future infection. He claims that vaccination from cowpox is safer than inoculation itself. It secures immunity without the risk which accompanies inoculation in certain cases, that his method of allowing the disease to first go through a cow makes the later infection so mild that the discomfort in attaining immunity is negligible.

The air is heavy with the load of ominous clouds: if Jenner fails, the storm will burst and a deluge of vituperative waters drown vaccination.

Jesty may have preceded Jenner by two decades and more, but without Jenner, vaccination lacks scientific proof, and can never have been accepted by the medical world.

A new chapter in the art of safeguarding man from disease is opened. The science of immunity receives its first scientific proof. Jenner uses his lancet to pull out the nails from the coffin prepared by

Hajang (tribal) mother and child,
Mymensingh, Bengal

Disease is waiting to strike Canarese workers
in a municipal workers' slum, Bombay City

smallpox and pushes aside the lid. Now mankind can breathe fresh air again. Smallpox is rendered impotent in its fell designs.

The idea that poison can protect against poison is an old one. But now science explains how it can be done in the case of smallpox. Soon, other infectious diseases are similarly rendered impotent. Typhoid vaccination now protects against typhoid fever. Diphtheria and scarlet fever are similarly resisted with confidence.

Napoleon learns about Jenner's thesis and orders all his troops to be immediately vaccinated. Napoleon, who with all his wars, cannot destroy more people than Jenner saves from smallpox, is a great admirer of the English scientist, in spite of his wrath against the 'nation of shop-keepers'.

In the U.S.A., the American Academy of Arts and Science holds a special session where the work of Jenner is announced. John Adams, the President of the U.S.A., graces the occasion with his august presence.

In 1880 Dr Waterhouse vaccinates his own five-year old son, and inaugurates the 'Jenner-way' in America. The whole family of Thomas Jefferson follows suit. Twelve years later, a whole tribe of Red Indians writes to Jenner: 'In token of our acceptance of your precious gift, we beseech the Great Spirit to take care of you in this world, and in the land of Spirits.' His own country, England, rewards Jenner with a gift of thirty thousand pounds before Jenner dies in 1823. Vaccination now spreads far and wide, so that a smallpox-pitted face becomes a rarity in Europe.

In 1898, from China arrives final conclusive evidence that Jenner's hypothesis is indisputable. General Leonard Wood mentions the experience of two battalions of American soldiers sent to China after vaccination. He writes: 'They were sent into a country infected with the most virulent type of smallpox where the death-rate was heavy, and all sanitary conditions were against them, and although living for months in towns infected with the most malignant type of smallpox to which they were constantly exposed, not a single case occurred in the regiment.'

The testimony is clear and unequivocal. To protect against smallpox, cleanliness and isolation from patients are not fundamentals, though they are both of undoubted value. It is vaccination alone that can give immunity.

Yours affectionately,
MASHI

LETTER XVII

LINA AND VIJAY,

It is the year 1943. Life in Ahmedabad is being endangered by smallpox.

In our family we are all vaccinated against the disease. One day we find little Menakshi absent at meals. She is feeling feverish and we feel disturbed at the news. I rush to her bedside and find her complaining of severe frontal headache. She vomits several times, but the headache persists. Severe pains in the back and across the loins appear with fits of shivering, which make her look very tired and fatigued. On the second day, she is burning with fever which reaches 105°F. A red rash appears all over her body. Delirium soon sets in. All the time she is thirsty and asks for cooling drinks. Her tongue is heavily coated, her breath offensive, bowels constipated, and her skin hot and dry. Day and night she tosses in her bed unable to get more than fitful sleep.

From this preliminary stage of infection to the stage of eruptions, is an anxious period of twelve days. It takes three more days for the eruptions to cover the body completely with papules. We watch the first papules appear on the face and forehead. They spread to the wrists and the back of the hands, then attack the trunk and the chest, the back and the abdomen. Finally they appear on the legs. At first they are tiny maculae. Soon they dig deep into the skin, surrounded by an areole. I notice that the parts of the body which are normally covered with clothing are less densely attacked. When the whole body is one mass of eruptions—a hideous sight—the temperature begins to fall. Little Menakshi now feels easier in her bed.

This brings her to the next stage of the disease. Sac-like cavities, resembling cysts or boils develop in place of the papules. The doctor calls it the 'vesicular' stage. The areole increases in area and in redness. Two days later, the temperature shoots up again. The eruptions are visibly swollen, and assume a tense hemispherical appearance. At this point the areole commences to fade, but the rash and the swelling on her face make her features unrecognizable. The doctor explains that inside the eruption pus is forming, and as the body is absorbing and fighting against the septic poison, a high temperature is the result. For five days, which seem like five years, we watch the struggle of the little child in the clutches of this horrible disease. The body at last conquers.

Now begins the drying stage. The doctor calls it 'desiccation'. The eruptions are shrinking and drying up. Dark brown crusts form on the outer surface of the shrivelled eruptions. Then the scabs

Cartoon by Gillray on vaccination
—*Anti-Vaccination Society*

begin to fall, leaving behind deep-set pits. Her hair starts thinning, and she actually sheds some of her nails. It takes her four weeks to be rid of the final scabs on the palms of her hands and the soles of her feet.

The doctor informs us that Menakshi is a lucky girl. The virus of smallpox which attacked her was highly malignant. It might easily have killed her. She could have developed broncho-pneumonia, spinal meningitis, melancholia with suicidal tendencies, madness, blindness or vicious boils all over the body. But as she had been vaccinated, the virulence of the disease had been checked.

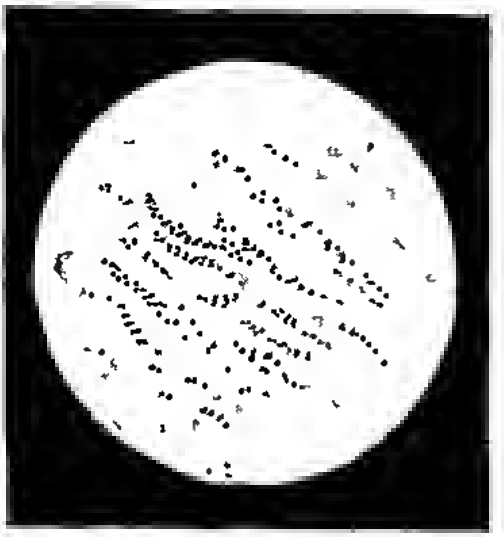
Let me record the conversation I had with the doctor.

'What causes smallpox? Is there a microbe responsible for this disease too?' I ask.

'Yes', replies the doctor. 'Smallpox has been traced to a filterable virus, which requires the electron microscope to spot. There are two chief types of smallpox: the Eastern kind which causes 'classical' smallpox, and the Western kind, derived from America, which causes a mild attack of the disease.'

'Can smallpox affect every race in every climate?'

'All races, both sexes, and beings of every age are susceptible to it —if not protected by a previous attack of cow-pox or smallpox or by efficient vaccination. It occurs in all climates, but in our hot climate the attack is more severe. It is the experience of doctors in England that the epidemic of smallpox usually occurs in winter and in spring, but dies out in summer. The explanation for this is offered by Leonard Rogers, an authority on this disease. He holds that the prevalence of smallpox is dependent on the humidity of the atmosphere.' When humidity is low, the graph of the disease shoots up, when humidity is high, the curve takes a downward dip.'



The smallpox virus

'Do you think smallpox has been checked by vaccination?'

'Most certainly yes. In pre-vaccination days, smallpox caused seven times as many deaths as measles, and seven and a half times as many as whooping cough. Before vaccination was introduced as a compulsory measure, smallpox was fatal for children. Nearly ninety per cent of the deaths that occurred in children under five years of age were due to smallpox. In 1871, a smallpox epidemic killed forty thousand people in the British Isles alone. In 1901 the epidemic, which lasted three years, gathered four thousand heads. Since 1935 there has been no fatality due to the disease in the whole of England and Wales except for three deaths in 1938. With vaccination, the killing propensities of the smallpox virus have been completely checked.'

'Till what time can one safely postpone vaccination?'

'Smallpox takes twelve to fourteen days to develop after a patient has caught the infection. A certain degree of immunity develops on the fifth day after vaccination. So it is open to you to get yourself vaccinated seven days after exposure and infection. Such protection is not a hundred per cent job, but it will help to tone down considerably the virulence of the disease. The best way, of course, is to get vaccinated at the earliest possible opportunity. You live in a city and the possibility of meeting an infected case or a carrier is always present. Anyone can casually contact you, in a bus or a tram, on the rail-

way station, down the street, in the bazaar, and so forth. You are running risks every moment'.

'How does one get smallpox?'

'The smallpox virus is a germ which is highly contagious. It can be conveyed in secretions of the mouth and the nose. It persists in the scabs which fall off from the drying eruptions. Even though scientists have found out that air cannot carry the virus for more than a short distance, you can get the infection through the respiratory tract, the way you breathe, and may be by direct or indirect contact. The infecting virus can be carried to you on the clothing or by hiding in the hair of a person coming from a smallpox case. Flies and domestic animals, like cats and dogs, can transmit the infection. Bedding and rugs of a patient, his clothes and towels, the corpse of the dead victim—all these can preserve the infection for you. That is the reason why all cases of smallpox are immediately isolated in the Infectious Disease Section of a hospital, until the scabs have completely separated from the eruptions. That is also the reason why all known contacts of a smallpox patient must be vaccinated, or if they refuse, quarantined for fourteen to twenty-one days.'

'When is it safest for a new-born child to be vaccinated?'

'Infants can be vaccinated safely in the first few weeks after birth. Ordinarily the best period is from the second to the sixth month. Re-vaccination is advisable after the seventh year, or when smallpox is raging in an epidemic form. Normally, vaccination immunity lasts ten years, and it is advisable to re-vaccinate after that period.'

'There is a disease called chickenpox. Is it a milder form of smallpox?'

'Cow-pox and smallpox are caused by the same virus. This has been established after prolonged arguments between scientists. Chickenpox and smallpox are separate diseases; the virus that causes the one is not the same as the virus of the other. The stage which precedes eruption in smallpox—fever, headache, vomiting, pains—is hardly there, or is of negligible severity, in chickenpox. Take again the rash and the papules. Their distribution as well as type is different; in chickenpox it first appears on the chest, the abdomen and the back. The trunk is the one part of the body most abundantly attacked. You will also find another difference. In smallpox all eruptions on a given part of the body mature together. In chickenpox, in the same area, you will find one lesion forming pus, a second drying up, and a third just being born, all side by side.'

'Doctor, tell me, what is the best treatment for smallpox?'

'First, as soon as smallpox has been diagnosed, the patient must be isolated, and his room and clothes thoroughly disinfected. If the patient is a child, the school must be informed; if employed in an office or factory, the management of the office or factory must be notified.

'Second, if the eruptions have not appeared, vaccination may prove useful in modifying the attack.

'Third, put the patient to bed, and give only light, easily digestible food.

'Fourth, all exposure to sun or weather must be avoided, and no scratching of the eruptions permitted.

'Fifth, all tight clothing should be removed, and no irritants applied to the body. Fresh air, cool surroundings, light bed clothes, tepid sponging of the body morning and night, mouth and nose to be thoroughly cleansed—that must be the routine.

'Sixth, give the patient as much liquid as he desires to drink. Regulate his bowels, and keep them in a healthy condition. If there is headache, give an ice bag; if pain in the legs, a hot-water bag.

'Seventh, when the eruptions have reached the pus-forming stage, you can paint the pustules with potassium permanganate solution. This will help to remove the bad odour of the pus. Ultra-violet rays may help to allay itching, and hasten the drying and crust-forming stage.

'Eighth, always be on the alert for complications. As and when the heart or the lungs or the brain is affected, take immediate help from the doctor to put it right.

'This is all the treatment necessary, once smallpox has attacked you. The oblations to the gods and goddesses will carry you nowhere, if you neglect the eight points science lays down for you.

'You must remember that smallpox is one of the three major epidemic diseases of India—the other two being cholera and plague. The number of deaths from the disease varies from year to year. The average for 1932-41 is seventy thousand per year. The League of Nations' Report declares that the incidence of smallpox in India is the highest among all countries from which statistics were collected. You must remember also that smallpox takes the biggest toll from children under ten years of age. Most generally, smallpox blinds the victim, if it does not kill. That is one reason why our country abounds in blind beggars.'

'What do you suggest should be done to wipe out smallpox? Is it possible to do so?'

'Of course it is possible to do so. We must make vaccination compulsory. Vaccination was first introduced in India in Bombay in 1830, and after a hundred and thirteen years only eighty-one per cent of the towns, and sixty-two per cent of the rural circles, have compulsory vaccination. It is still optional in whole provinces, like the North-West Frontier Province, United Provinces, Sind, Coorg, and Ajmer Merwara. The preparation of vaccine-lymph is undertaken in only seven provinces—at Belgaum in Bombay, Calcutta in Bengal, Guindy in Madras, Nagpur in the Central Provinces, Patwa Danga in the United Provinces, Lahore in the Punjab, and Ranchi in Bihar. Again there is not enough propaganda done. People are still ignorant about the safety of vaccination, and the immunity it procures. Arm to arm inoculation of the old days was dangerous because not only was the dosage uncertain, but it could transmit syphilis, tetanus, leprosy or tuberculosis with the smallpox germ. Vaccine-lymph is taken from the calf, and is quite safe against infectious diseases. The danger of the tubercle bacillus has been neutralized by adding glycerine to the lymph, which kills it without fail. The manufacturers of the vaccine-lymph compare it with the purest milk. This is no vain boast. It is the truth.

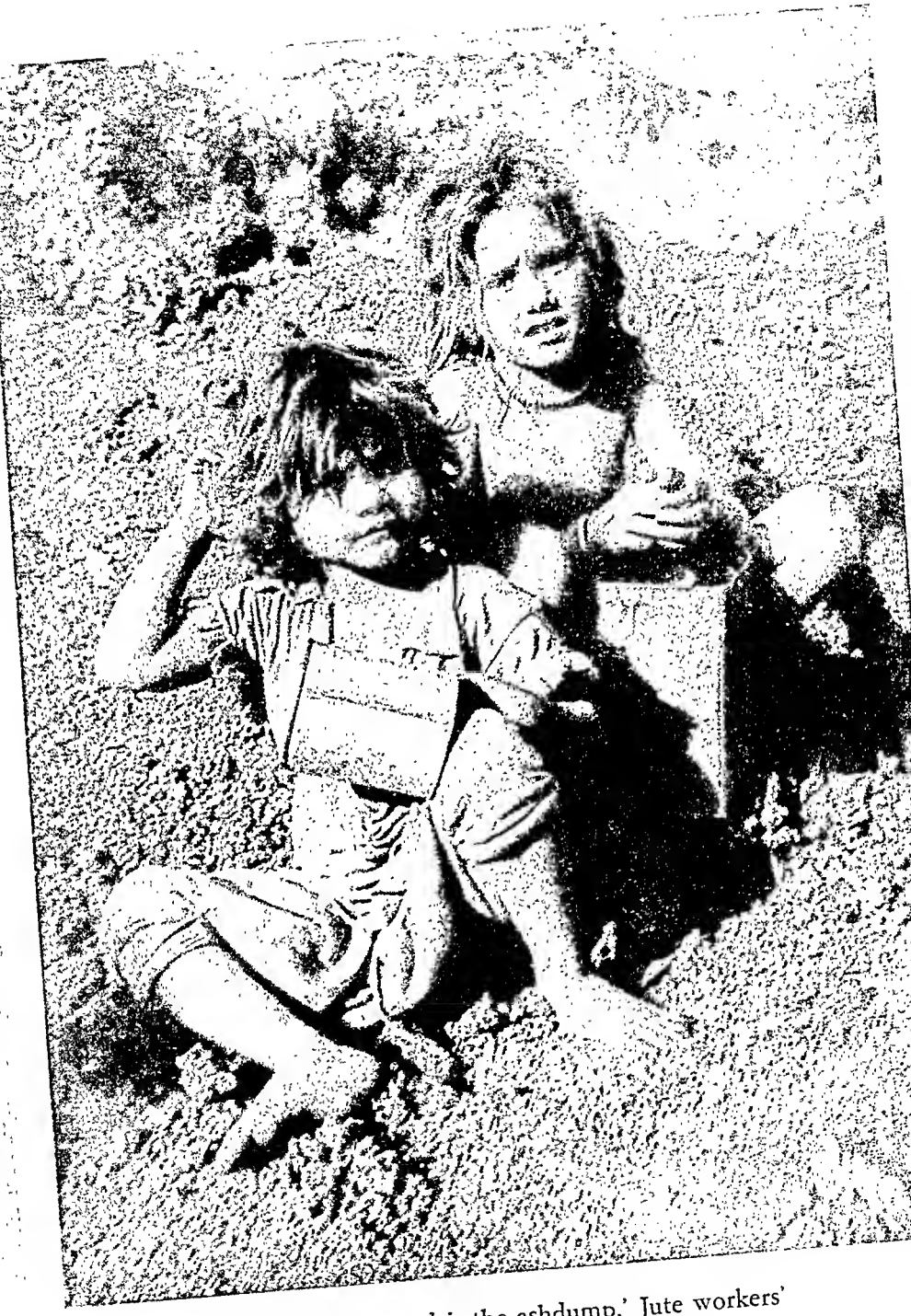
'Sir George Newman once said: "Smallpox is the perquisite of those who desire it." There is no excuse for a person when he gets smallpox. Science has provided the most perfect protection. The law ought to punish a smallpox patient, because by his indifference or cussedness, he jeopardises the health of the community, and especially of young children.

'I shall cite an instance of how smallpox is checked in the British Isles. On 29 May 1942 a ship arrives in the Clyde from Bombay. It has a passenger, who is certified by the ship's captain as suffering from measles, complicated by pneumonia. The Port Health Authorities examine the case, and pronounce it as smallpox of the Eastern strain—Variola Major. All passengers and the whole of the crew are immediately vaccinated, and all health officials of the places for which they leave are duly informed to keep a sharp lookout for smallpox. Several of the passengers develop mild attacks of smallpox; evidently the infection has been caught on the boat. On 28 June five cases of smallpox occur in Glasgow among persons who have no contact with the infected ship. The whole of Glasgow is immediately notified by the health authorities to get vaccinated. In ten days, five hundred thousand men, women and children are immunized. The epidemic has been nipped in the bud. In all, forty-two cases of

smallpox are traced, ten being ship-passengers Only seven cases prove fatal. There is no panic, no holding up of business, no hasty flight, and no maiming worth the name by the disease. The steam-roller of smallpox cannot even get going. Perfect health organization, aided by vaccine as the chief barricade, has blocked the path of gruesome murder. Here is an example worth copying.'

Thus I question, and he answers. Little by little, he removes the cobwebs that have been woven in my mind by popular superstition Now the world is no more an incoherent mass of dark sinister shadows, demanding blind faith in order to live. The refulgent light of science dispels the darkness of the night, and shows man the one sure method of turning to ashes yet another disease. So disappears smallpox.

Yours affectionately,
MASIH



'Our playground is the ashdump.' Jute workers' children, Budge-Budge, Calcutta

We have no bread winners Her husband and two elder children died during the famine

Tidal wave victim Andhradesa

LETTER XVIII

THE BLACK DEATH: PLAGUE

LINA AND VIJAY,

The other day, rummaging in the library for books on plague, I came across the interesting Journal of Daniel Defoe. It portrays very vividly the sad and dismal days which London experienced during one of its greatest trials—the Black Death of the year 1665. I propose to quote from it in order to give you an idea of what plague can do to a civilized people.

'The face of London was now indeed strangely altered ... Sorrow and sadness sat upon every face ... London might well be said to be all in tears ... Tears and lamentations were seen almost in every home ... Death was before their eyes, and everybody began to think of their graves, not of mirth and diversions ... The people ran to conjurors and witches, and all sorts of deceivers to know what should become of them ... they were as mad upon running after quacks and mountebanks and every practising old woman for medicines and remedies, storing themselves with such multitudes of pills, potions and preservatives, as they were called, that they not only spent their money, but even poisoned themselves beforehand ... some with mercury and some with other things as bad ... wearing charms, phillies, exorcisms, amulets, and I know not what preparations to fortify the body with them against the plague.

'Here comes the cart which collects the dead from door to door. The buryers were so wicked as to strip the dead in the cart and carry them quite naked to the ground ...'

Defoe describes the condition of the people: 'They were running out of their own government ... raving ... oftentimes laying violent hands upon themselves, throwing themselves out at their window, shooting themselves ... Mothers murdering their own children, in their lunacy. Some dying of mere grief, as a passion; some of mere fright and surprise, without any infection at all; others frighted into idiotism and foolish distractions; some into despair and lunacy; others into melancholy madness. The pain of the swelling was in particular very violent, and to some intolerable ...'

As I read the book, I am strongly reminded of London during the recent man-made pestilence—World War II as it devastates the city and indiscriminately kills a vast number of the population. The collective heroic spirit shown by the people in the War is highly laudable.

The Englishman with his back to the wall shows great stature and grim determination. This is very different from the lack of discipline and organization recorded by the pen of Defoe in his Journal. London in 1941 and 1942 proves the value and necessity of an all-round organization with great emphasis on provisions for health.

London is not the only city to stand up against the fury of human maniacs. Leningrad, Moscow, Stalingrad show great discipline and perfect organization against odds never dreamt of before. Not a single epidemic occurs in any one of these cities in spite of the rain of bombs dislocating and disrupting the medical services.

The civilized world recognizes today, as never before, the importance and value of medical organization. Medicine stands first—shoulder to shoulder with food—in war as in peace.

Let us examine systematically the history of plague.

Plague is a disease as ancient as the hills. It is known by many names. It has been called 'Oriental Plague', 'Pestis' and 'Pestilentia'; the Russians name it 'Chuma', the Japanese 'Yeki', and the Chinese 'Shu-Yi'. In our own country it has been referred to as 'Mahamari' or 'Pali'.

The Philistines rob the Ark from Canaan and when they restore it, they make offerings. These offerings are golden images of mice and buboes. That is thirteen hundred years before Christ. This may be evidence of plague.

Rufus is a physician, who lives about 100 A.D. He refers to a disease which resembles bubonic plague in Egypt, Libya and Syria some two hundred years earlier.

Justinian's plague has been recorded by many writers.

Beginning in Southern Egypt it spreads 'to the ends of the inhabitable world'. In Constantinople it kills five to ten thousand people daily. In all a hundred million are killed, towns and villages are deserted for hundreds of miles, as plague reigns supreme in the then civilized world for nearly half a century. When plague finally recedes, it hits Constantinople again. Tradition has it that the farewell thrust from plague is so severe that the piles of the dead are higher than the towers of the city walls.

For nearly eight hundred years, there is no evidence of plague; it is hibernating and is not heard of in Europe.

In the fourteenth century, plague appears again in Constantinople and it spreads to the whole of Greece and Italy. It does not leave Europe for the next three hundred years. In the Middle Ages, 'The Black Death' takes twenty-five million victims, one-fourth of

the population of Europe. In Great Britain the toll is higher; half to two-thirds of the people perish miserably without any effective aid. Italy is ravaged no less than sixteen times.

The scaffold and the Rod for plague-spreaders
—*Milan engraving* 1630

Europe is in the grip of a wild panic. Confusion is worse confounded as the rich desert the cities and withdraw to isolated country retreats. Society runs amok. Boccaccio's *Decameron* portrays the life of gay young people who fly from plague-ridden Florence in 1348: 'The numbers of both sexes in the prime and vigour of youth... after dining heartily with their friends here have supped with their departed friends in the other world!'

All those who can run away do so leaving behind old mothers and infirm fathers, little children, the sick and the ailing, the lame, the halt, and the blind. There is a mad scramble at the wharves to sail away in ships, only to discover that plague kills on the waters as swiftly as on land. There are cases where the whole crew perishes, and the ship floats about or flounders on rocks, with not a soul alive on board. Churches are considered sanctuaries, but here too plague penetrates. Thieves and robbers appear everywhere, looting deserted houses, only to be robbed in their turn of life itself by plague.

The 'Black Death' in London is named 'poor man's plague', because the rich, including the king and his nobles, abandon the city. Their maxim is 'Quick, Far and Late', leave quickly, run the farthest, and return as late as possible. The courts collapse. The prisons become cemeteries. Even the physicians take to their heels. Only the London apothecaries stand their ground. The infuriated populace

vents its impotent anger on 'plague-spreaders'. Innocent men and women are dragged to the market place, humiliated, tortured and finally done to death with horrible cruelty.

The Venetians quarantine ships, the French and the Italians disinfect their houses with vinegar and scented 'plague-water', the English heap coal fires in the centre of streets and kill dogs because they suspect them to be plague-carriers. But nobody suspects the rats.

Physicians today speculate about the origin of the name 'Black Death'. Boccaccio, who lived through the epidemics, writes: 'It is the peculiarity of the disease to show itself by black or blue spots, which appear on the arms of many, others on the thighs and every part else of the body—in some great and few, in others small and thick.' The tendency to skin hæmorrhages is one explanation. The other may be the dark bloody sputum in pneumonic plague.

Plague not only makes the man in the street a bundle of nerves and superstitions; it also shakes the confidence of the medical faculties in their medicines. For instance, here is a statement of the Paris Medical Faculty. It reads: 'It is known that in India, in the region of the Great Sea, the stars that oppose the rays of the sun and the warmth of the heavenly power, exert their power especially against that sea and struggle violently with its waters. For this reason vapours frequently arise which cover the sun and change its light to darkness ... finally the sun and fire act so violently on the Sea that they attract a large part of it and the sea waters rise in the form of water ... Fish die in the spoilt waters ... as a result evil vapours develop and suffocate human beings.' It recommends remedies against plague: fumigation with pine wood, laurel, camomile, and wormwood, accompanied by a diet in which no relevant dietetic principle is observed.

From the end of the seventeenth century, plague slowly but steadily retreats from the West to the East.

In the ancient literature of our country, there are references in the *Bhagwat Purana* to plague, the disease being characterized as one of man as well as rats. The *Purana* recommends that homes where dead rats have been found should be abandoned peremptorily. After that, we have records of the activity of plague from the eleventh to the seventeenth century. Then plague disappears for no ostensible reason for a whole century, to appear again in the first half of the nineteenth century. From 1812 to 1821, Gujarat, Kathiawar and Cutch are overrun; from 1836 to 1838, Rajputana suffers the same fate. There are sporadic outbreaks, suspected to have been imported from Iran. But in Kumaon and Garhwal, the foot of the Kailash

and adjoining Himalayan peaks, an endemic focus of plague is traced.

The first clear mention of plague in old Chinese literature occurs in 610 A.D. in a medical treatise by Ch'ae Yuan-fang. It calls the malignant bubo 'E-he'.

The year 1894 witnesses plague ravaging Canton. The Chinese already connect rats with plague, though they do not know how the rat is involved in spreading the disease. A Canton official collects no less than thirty-five thousand rats dead of plague in one month, and an investigator by the name of Rennie dissects a large number of them. He finds congestion of the lungs in about half the rats and glandular enlargement in nine out of every ten rats he cuts open. He writes: 'Is the disease in man and animals identical? Should bacteriological examination give an answer in the affirmative, then we must recognize that these rodents are active agents in transmitting the disease from place to place for long distances overland.'

Before Rennie records his hypothesis on paper, or even thinks it out, Lowry has already observed a plague epidemic taking toll in Pakhoi in 1882. He writes: 'In nearly every house where the disease broke out, the rats had been coming out of their holes and dying on the floors.' When he dissects the rats, he also finds congestion of the organs and enlargement of the liver.

So Rennie confirms Lowry.

In the diary of Yersin we find, underneath the date 23 June 1894, this entry: 'I search and find the organism in the corpses of dead rats, and there are many throughout the city (Hongkong) ...'

But the medical authorities discountenance these valuable attempts to get to the bottom of the plague mystery. The official report on the Hongkong epidemic of 1894 unequivocally states: 'The question of the infection of rats previous to the epidemic being noted in human beings has been made too much of.'

Hongkong begins a rat-destruction campaign only in 1901. By that time, the absurd theories about plague have been completely torpedoed. Kitasato, the Japanese pupil of Koch, arrives in Hongkong on 12 June 1894, accompanied by Aoyama and several assistants. Aoyama, two days later, on 14 June, is doing post-mortem examination of a plague victim when Kitasato spots a large number of plague bacilli in the buboes as well as the viscera of the victim's body. But eleven hours have elapsed since the man drew his last breath, and the Koch in Kitasato is reticent about drawing a final conclusion.

On that very day, Kitasato examines the blood of a plague patient, and declares that he has located bacilli resembling chicken-cholera bacilli. He inoculates this bacilli into various animals and birds; all die, except the pigeon. He writes in the *Lancet* of 25 August that the bacillus is a rod with rounded ends showing bipolar staining.

Kitasato

Yersin, the Swiss bacteriologist from Paris, reaches Hongkong on 15 June 1894. He is not allowed by the authorities to do postmortem of plague cases. He cuts the buboes of dead plague victims and prepares smears and cultures from the matter he takes from them, and sends them to the Paris Pasteur Institute. He too notes 'very small rods, with rounded ends, and lightly coloured'.

Kitasato asserts that his bacillus must be different from that seen by Yersin.

There has been a controversy in the scientific world as to who found the plague bacilli first. National rivalry of the type we witnessed between the followers of Pasteur and Koch, is now re-appearing as continental rivalry between the Asiatic and the European. Unhealthy, unscientific claims and counter-claims are made on either side. We shall keep clear of this controversy and assert with the doyen of plague workers, Wu-Lien-teh the Chinese: 'We owe to Kitasato the earliest account of the organism, and to Yersin its first detailed and accurate description ... Although it was left to investigations in India to prove definitely the source of the epidemics from rats as well as the role of the fleas infesting these rodents, the actual foundation was laid at Hongkong by the discovery of the bacillus *Pasteurella pestis*.'

Plague bacilli

Kitasato is known in Japan as the 'Japanese Koch'. His grateful countrymen build a temple around the hair from the august head of Koch to commemorate the visit of Koch to Japan. Koch is accorded a magnificent reception for having taught the technique of science to Kitasato, which results in his discovery of the plague bacillus. Plague

is one of the most dreaded diseases in the East. A more touching tribute no country has paid to the greatest scientist that ever lived.

In 1897 Ogata suggests that the plague bacilli is transferred by the rat-flea from rat to man. It is however left to Liston and his associates in 1905 to fully work out the method of transmission of the infection.

Liston is of the opinion that 'the disappearance of plague from Europe in the seventeenth and eighteenth centuries coincided in the main, in point of time, with the appearance of the sewer rat and the disappearance of the house-rat ... The changes in the habits of men in Europe about the same time led to the exclusion of rats from human dwellings and ultimately favoured the substitution of one species of rat for another.'

But many investigators, led by Jorge, have been hostile to the theory advanced by Liston. They take their stand on the assertion that the sewer-rat appears a considerable time after plague vanished from Europe.

The modern name of plague bacillus is *Pasteurella pestis,* because it is a near relative of the group *pasteurella,* 'the hæmorrhagic septicæmia group'.

The plague bacillus is a short ovoid bacillus with a length of 1·5 to 1·8 microns and a width of ·5 to ·7 micron. In practice the microbiologist finds that it is very variable in shape, resembling even mould or yeast-like formations. Its temperature range is a very wide one, ranging from 0° to 43·5°C. Just as it adapts itself to varying temperatures it accommodates itself to all kinds of media, commonly used in the laboratory.

Even though scientists have located the murderer, studied its habits closely, measured it, and watched it grow on different media, cases have occurred when the bacillus has been nimble enough to circumvent the precautions taken, and kill, or very nearly kill, the hunters on the track. I shall cite some interesting cases of medical martyrs who jeopardised their lives whilst trapping this cold-blooded pest.

Dr Sticker is one of the German Plague Commission which comes out to India in 1896. He works in Bombay and visits plague-infected houses to perform post-mortem examinations. When facilities are wanting, he kneels on the floor, and does his work even without assistants and sometimes without even water to wash his hands.

In the second week of March, he cuts and pricks himself repeatedly at post-mortem work. On 29 March he notices a small painful vesicle on his right thumb. He hurts the thumb again the same day

while playing with his pet dog, and the pain becomes unbearable all over the arm. The vesicle begins to grow bigger and two red lines appear on the thumb and the arm.

Yersin

He applies oil compresses to the arm and the arm-pit to relieve the burning pain.

Next day, the pain in the thumb becomes more intense. The axillary glands are now almost painless, the red lines on the upper arm disappear, but movement is still difficult for the hand and the fore-arm. The contents of the pustules are examined under the microscope and show a few bacilli resembling the plague bacillus. Dr. Sticker refuses serum injection, and prefers boric acid compresses. Now the temperature begins to rise. Severe pains in the head and neck keep him sleepless.

On the third day, the headache disappears, but the pain is still lurking at the back of the eyes, in the lumbar region and in the wound. Another day and he feels better and sits up in a chair for four hours, but his appetite is poor, whilst dizziness still persists. The fifth day witnesses the disappearance of the headache and the return of appetite. The seventh day shows further improvement, and he is discharged from hospital. However for a fortnight he cannot even read a few lines without feeling faint and dizzy.

Dr Sticker escapes death by the skin of his teeth. Other plague-workers are not so fortunate.

Dr Spielberg is a social worker who has volunteered to do plague work during an epidemic. She has some bacteriological training but is not allowed to handle living plague bacilli. When her Chief is away, she disobeys his orders, and in the process of preparing plague vaccine, she spills some of the emulsion on her frock. From 8 December 1923, the date of the accident, to 12 December, nothing happens, and the incident is forgotten. But on 13 December she

'What will tomorrow bring for them?' A woman and her grandchild before their empty cooking-pot in a peasant hut near Chitaldroog, Mysore State

Poverty sickness and death is their heritage A peasant woman and her children Sheitally Travancore State

feels feverish and complains of pains in the chest. She tries to be brave and denies every possibility of plague infection. Two days later, she throws up bloody sputum, which when examined under the microscope gives conclusive proof of *Pasteurella pestis* with streptococci. She dies that day. Post-mortem examination shows pneumonia in both lungs. It is a case of pneumonic plague.

One of her attendants, who gave her a new compress without a mask on the last day, also catches the disease, but is saved.

Now I shall relate to you a remarkable case of how dangerous a weapon knowledge of bacteria can be in the hands of unscrupulous persons.

On 12 May 1932 the Haffkine Institute, Bombay, receives a reply-paid telegram from one Doctor T. M. Bhattacharya, seeking a virulent plague culture. He is asked to apply in writing, stating the purposes for which it is required. Two days later, the written application is received. Dr Bhattacharya evidently needs the culture for experimental work on animals. But the Haffkine Institute is not convinced, and refuses the request.

Towards the end of the month, a research worker in the Calcutta School of Tropical Medicine makes a request for plague culture. This time the Haffkine Institute obliges. It is found later that Dr Bhattacharya inspired this request, but the plague culture evidently dies on its way to Calcutta and proves to be useless.

A whole year goes by. In the middle of 1933 a Mr Pande visits the Haffkine Institute and tries to procure plague culture from the various assistants there. He does not succeed. So he contacts the Chief Medical Officer of the Bombay City Isolation Hospital and recommends Dr Bhattacharya as a promising research worker and medical man who has found out a cure for plague. He says Dr Bhattacharya's talent is being wasted, because he has no opportunity to try out his cure. There are no plague cases in the hospital, so plague culture is procured by the Superintendent of the City Isolation Hospital from the Haffkine Institute, and permission is given to Dr Bhattacharya to work in the hospital. Dr Bhattacharya tests this plague culture on white rats. He finds it fatal. Soon Dr Bhattacharya concocts an excuse that he is urgently required in Calcutta, and leaves Bombay. He promises to return later on to continue his investigations. But he never keeps his word.

In November 1933 the plague culture taken by Dr Bhattacharya is used for the purpose of murder.

Benoy and Amar Pande are step-brothers and the only heirs to a

vast landed estate, Pakur Raj. Amar Pande is leaving Calcutta from Howrah station when he feels a prick on his arm in the midst of the last minute rush on the platform. He complains to his friends who have come to see him off that some unknown person brushed past him and pricked his arm. Benoy Pande is present and asks him to dismiss the idea from his head.

Amar Pande becomes seriously ill in his village and is brought to Calcutta by some of his college friends unknown to the elder brother. In Calcutta, the physicians diagnose severe septicæmia and take the help of a bacteriologist from the School of Tropical Medicine to decipher the cause of the disease. Before the result of blood examination can be obtained, Amar dies and is cremated. Some days later, the School of Tropical Medicine notifies the family as well as the Calcutta Public Health Department that Amar died of plague.

But plague is unknown for years in Pakur Raj. The family solicitor suspects foul play, and arrives in Bombay to make inquiries about the mission that brought the elder brother to Bombay in the middle of 1933. As soon as he unearths the links of Benoy Pande with the Haffkine Institute and the City Isolation Hospital, he hands over the case to the Crime Branch of the City Police.

Pande and Dr Bhattacharya are placed on trial for murder. Both Pande and Dr Bhattacharya are convicted and sentenced to penal servitude for life.

The Public Prosecutor claims that the crime is 'unique in its conception, diabolical in its motive and most tragic in its consequences'. The convicting judge calls it 'murder, diabolically conceived, and executed in cold blood'.

The discovery of Kitasato and Yersin has helped millions to be saved from gruesome death; it sent one innocent human being to his untimely funeral pyre.

Science is a double-edged weapon. It depends on who uses it and how—for happiness or for murder.

Yours affectionately,
MASHI

LETTER XIX

LINA AND VIJAY,

It has often happened to me that when I have desired a thing most ardently, the wish has been fulfilled in the most unexpected manner. So it happened when I was struggling with the literature on plague and its symptoms.

I am sitting in the garden revelling in the quiet beauty of nature. The appearance of a doctor friend is timely. I take the opportunity to remove the many doubts that assail me. I ask him to explain to me the symptoms of plague. I here record what he told me.

'You must realize that plague does not make a visible appearance when you have been marked out as a victim of the disease. Before its noticeable symptoms are witnessed, there is normally an incubation period lasting from two to eight days. In rare cases it has been known to extend to fifteen days. On the other hand, in highly malignant epidemics, plague has appeared within three hours from the moment of infection.

'In a small number of cases, a preliminary stage precedes the stage of actual invasion by the disease. You get pains all over the body, suffer from physical and mental depression, giddiness, feeling of coldness, palpitation of the heart and a dull pain in the groin.

'Next comes the stage of invasion. In nine cases out of ten, the disease makes itself visible suddenly, accompanied by low fever, headache, extreme feeling of fatigue, aching of the limbs, drowsiness, and disturbed dreams. The sense of chilliness rarely extends to rigors. The face shows characteristic marks; it acquires a drawn and haggard expression, the eyes become sunken and bloodshot with a vacant stare, the pupils sometimes dilate, giving the impression of a person struck with horror or extreme fear. The gait also becomes peculiar; the patient staggers like a drunken person, walking as if in a haze. Nausea, vomiting and diarrhœa may or may not be there. All this may last a day or two or may be totally absent.

'The stage after this is the stage of high fever. The thermometer rapidly records 103º or 104°F—even 107°F—with a high pulse and respiration rate. The face now looks swollen, the eyes still more sunken and fixed, the hearing hard, the skin dry and burning. The mouth gives yet another indication to the doctor: the tongue is swollen and coated with a creamy fur, which dries and becomes deep brown or black; sordes form on the teeth and about the nostrils and

lips. The patient is so exhausted that he can hardly speak loud enough to be heard. Prostration is extreme and with it, inordinate thirst develops. There may be delirium or none at all. Coma, convulsions, urine retention and other nervous disorders may appear. Sometimes vomiting difficulties occur. Some cases become highly constipated, others develop diarrhoea. The liver and the spleen are both enlarged. The pulse loses tone very rapidly and becomes small, fluttering and intermittent. The heart also is affected. It may be dilated, with the first sound being very feeble or absent.

'We have now reached the stage of the definite appearance of the bubo. In three out of every four cases, the bubo appears in the groin —most probably in the right groin. It makes its appearance in the arm-pit in 20 per cent of the cases. In the remaining cases, the glands at the angle of the lower jaw are affected, especially in children. The bubo is usually single but can form simultaneously on both sides of the body. It varies in its size from a walnut to a goose-egg. Pain is not a necessary concomitant of the bubo. In some cases it is so severe that it is unbearable; in others, it is totally absent.

'In cases which are to recover, profuse perspiration sets in. This may occur even without the bubo having put in an appearance. The tongue moistens and the temperature and pulse rate comes down. The bubo may further enlarge, soften, and then burst, discharging foul-smelling pus and slough. The bubo may even subside by itself or remain static for weeks. But these are rare cases. Ordinarily if the patient has tided over the disease, convalescence sets in any time from the sixth to the tenth day. The sores left hy the buboes take months to heal and need regular cleansing.

'Haemorrhage is not an unusual feature of plague cases. Patches may be seen on the skin, or bleeding may occur from the mouth, the nose, the lungs, stomach, kidneys or bowels. Hæmorrhage is considered a sign of great malignity in the epidemic. Pregnant women invariably suffer from miscarriage, the foetus showing infection of plague.

'Death can take place any time in the course of the disease, but usually occurs hetween the third and the fifth day.

'All this applies to bubonic plague, which is the type we commonly find in our country. There are however two other kinds of plague: Septicaemic plague or *pestis siderans* and Pneumonic plague.

'In Septicaemic plague, the bacilli are found circulating in the blood. Great weakness and utter prostration, delirium, restless movements of the hands, stupor and coma bring death within the first three days Haemorrhage is frequent in these cases.

'There is a mild variety of plague known as pestis minor or larval plague. The buboes appear and disappear without much complication from other symptoms. This plague is not dangerous to the patient, but is of great importance to the health worker, because it can develop into an epidemic which may prove to be virulent'.

The doctor friend recommends that I read the report of the Indian Plague Commission. It functioned in our country in 1907 and rendered invaluable service in unravelling the mystery which surrounds the transmission of plague from rat to rat, from rat to man, and from man to man. The Commission is responsible for a detailed study of the rat flea, its habits and its modus operandi under controlled laboratory conditions, thus providing an opening for the health worker and the doctor to devise methods of combating a plague epidemic.

The report of the Commission is a veritable honeycomb of wisdom regarding plague. The Commission reaches positive conclusions through a maze of extremely ingenious experiments.

Six godowns are specially erected in Bombay and hundreds of guinea-pigs and rats are collected for controlled laboratory tests.

The first problem tackled is: Is it possible to pass on infection by direct contact?

On 8 January 1907, the scientists open the doors of godown No. 5, a flea-proof room with a roof of reinforced concrete. Five guinea-pigs are inoculated with plague bacilli and left inside the godowns in company with twenty-five healthy ones. They all eat out of the same dishes and live in the same confined space. On the 12th, all five plague-infected animals die; they are not immediately removed but allowed to lie for some hours. New additions of infected animals are daily put in. Between the 15th and the 24th some twenty-five are thus introduced into the godown. By 31 January all the infected animals are dead. The experiment is carried on till 21 February. The twenty-five healthy guinea-pigs roll in the faeces and urine of the infected ones; their food is fully contaminated every day and several times a day; but none of them are affected. They remain safe against all attacks of plague.

The experiment is repeated with rats replacing the guinea-pigs. There is no difference in the result. It is found that so long as you exclude the flea, plague does not spread by contact however intimately the animals may live with the faeces and urine of plague cases.

The next set of experiments is with young guinea-pigs who are suckled by plague-infected mothers, to the point where the mother

dies of plague. So long as no flea is allowed to get inside the godown, the young ones remain safe from the disease.

Now another set of experiments, under the contrary conditions, is tried out. Godowns No. 1 and 2 have country-tiled roofs in which abundant rat-fleas collect. Plague-infected guinea-pigs are placed inside these godowns. In course of time they die. The dead animals are removed, an interval of two days allowed to elapse, and new healthy guinea-pigs are introduced into the godowns. There is no contact permitted with any plague-infected animal. All the same the new guinea-pigs develop plague and die.

Evidence points to the flea as the murderer. But scientists do not jump to hasty conclusions, and are never satisfied with one observation, unless and until all the ramifications arising from it are explored.

The godowns No. 1 and 2 are again requisitioned. They are abounding with fleas. Plague infected guinea-pigs are sent to stay in them, die and are removed. After an interval, healthy guinea-pigs are introduced but in cages. The first cage is hung two feet above the ground; the second two inches above the ground; the third, left on the floor. The result is revealing. The guinea-pigs in the first cage never catch plague; the cage does not even contain a single flea. The second cage has twenty-seven fleas and all the guinea-pigs become victims of plague. In the third cage the guinea-pigs also die but the number of fleas is much larger, a hundred and twenty-five. High jump tests for the flea corroborate the result. A flea can jump anything between four and six inches, but beyond that height, the flea feels as helpless as an anti-aircraft gun when faced by a bomber in the stratosphere.

But the Commission members are not fully satisfied. A fresh bunch of animals are left in the infected godowns in cages with fine wire gauze or surrounded by strips of 'tanglefoot'. The animals remain safe against plague. Other cages which are not similarly protected prove to be death-traps.

Another observation is gleaned: aerial infection is a myth in bubonic plague. Both sets of cages are equally exposed in the same godown at the same time; the protected ones procure immunity, the unprotected procure death by plague.

Now a new problem occupies the stage: Can infection spread through excreta or soil which is infected?

Urine and faeces of infected animals are rubbed into abrasions and scars made on healthy ones. Several hundred tests are made, but only in one or two cases does infection result.

Plague cultures are now heavily sprayed on cow-dung and chunam floors. Healthy animals are allowed the freedom of the floors. The cow-dung floor is known to remain infective for twelve hours; the chunam floor for six hours. But a very small number of animals so exposed catch the disease, and those only when the floor is still wet.

Does disinfection affect the flea? Two sets of houses are commandeered for experiment. In one set thorough disinfection is undertaken with a 1 in 750 strength acid solution of perchloride of mercury, sufficient to kill all plague bacilli; the other set of houses is not disinfected. Guinea-pigs are let loose on the floors of both the houses. There is a fatality of 30 per cent in each case! What is fatal for the bacilli is harmless for the flea.

The Commission now turns its attention to popular beliefs. One is that rats eat the excreta of infected rats and human beings, and thus catch plague; in the alternative they become infected by eating food contaminated by plague excreta. Some people suggest a further amendment: healthy rats get plague by eating dead infected animals. The Commission pricks the bubble of these beliefs.

A hundred and ninety-four rats are given the urine of human plague cases to drink. The blood of these human patients is teeming with plague bacilli at the time they pass the urine. But all the rats remain unaffected.

Healthy animals are continuously given food contaminated with urine and faeces of plague-infected animals. None develop the disease.

Rats are fed on separate organs and whole carcasses of dead plague-infected animals. They develop plague, the bacilli gaining access through the mucous membrane of the mouth, throat and intestine. The Commission, however, is not to be outdone by this surprising result. Post-mortem examination of these rats is undertaken, and shows well-marked lesions in the intestines of each and every one of them. The Commission points out that post-mortem of normally plague-affected rats does not show pathological changes in the stomach and the intestines. The conclusion is evident: a rat epizootic is not caused by the process of eating dead plague-infected rats.

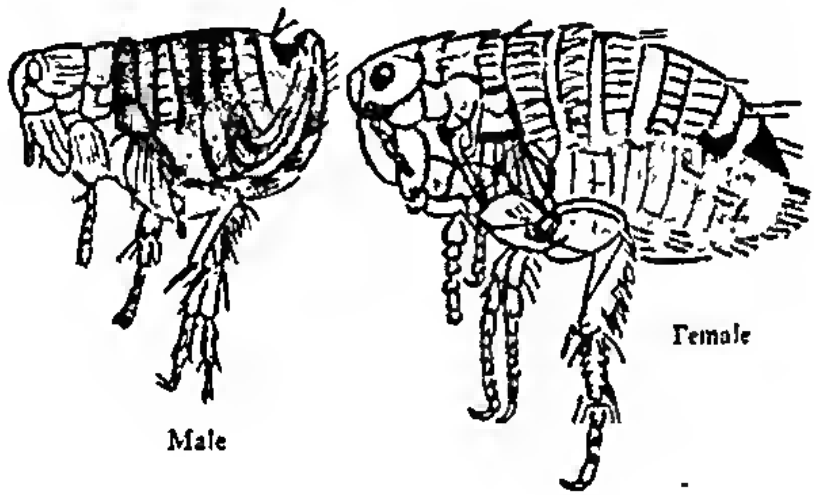
In human beings, not a single post-mortem case has pointed to the bacilli having gained entrance through food and the intestines.

So, at last the Commission turns its attention to transmission of infection by means of the rat-fleas.

Gauthier and Raybaud, two French scientists, have already, in an unequivocal manner, conveyed the disease from animal to animal by means of fleas in their laboratories.

Rothschild has described *pulex cheopis* as 'the commonest rat-flea', and the Commission finds it to be the species of fleas that live on Bombay rats. It argues: If a biting insect is the agent of transmission of plague bacillus, this *pulex cheopis* may supply the clue to the mystery.'

A new series of experiments are devised. A glass-case is constructed to contain two wire cages side by side. The whole apparatus is covered with fine muslin to prevent the escape of fleas. The cages are so made that a rat in one cannot contact the rat in the other; the only common factors are the fleas which can jump from one cage to the other. A plague-infected rat is allowed to die in cage A. The fleas make a good meal. In cage B, a healthy rat is now placed. He



Plague fleas

catches plague and dies. The experiment is repeated over and over again. Out of sixty-six white English rats and wild Bombay rats, nearly thirty contract the disease.

A clean flea-proof cage is now requisitioned. Fleas from a dead plague rat are taken and placed on healthy rats and the rats locked up in this cage. In twenty-one out of thirty-eight experiments, plague is successfully transmitted.

Plague-infected fleas are bottled in test-tubes, the mouth of the tubes being covered by thin muslin. The fleas are now permitted to bite healthy guinea-pigs through the muslin. The guinea-pigs catch the plague.

Once again the Commission reverts to godown No. 2, which has a native-tiled roof and is swarming with fleas. On 8 January 1907 the beginning of the plague epizootic season, five guinea-pigs are

Flowers born to wither in rags and filth. Kashmiri carpet-worker and child

'Why was I born?' A woman deformed from birth, in a village in South India

inoculated with virulent plague cultures and locked up in the godown. All five die of plague by the 11th. The dead are removed, and in their place twenty-five healthy guinea-pigs introduced. An epizootic begins, and in a fortnight all die of plague.

In the non-epizootic season—on the 13th of June—fifty healthy and ten plague-inoculated guinea-pigs are left in the same godown, No. 2. By the 29th all the inoculated die ; of the uninoculated, four die of plague, but the rest remain healthy.

The Commission drafts a fresh conclusion: the virulence of the flea varies with the season; the number of fleas, which can intensify or tone down the epizootic and the epidemic is also controlled seasonally.

Plague bacilli are traced in the dissected stomach contents of one out of eighty-five human fleas and twenty-three out of seventy-seven rat fleas.

This is found to be the rough proportion between a rat-flea and a human-flea, so far as carrying the burden of guilt of plague transmission is concerned.

The road travelled by the plague bacillus in order to get inside a human body now engages the attention of the Commission.

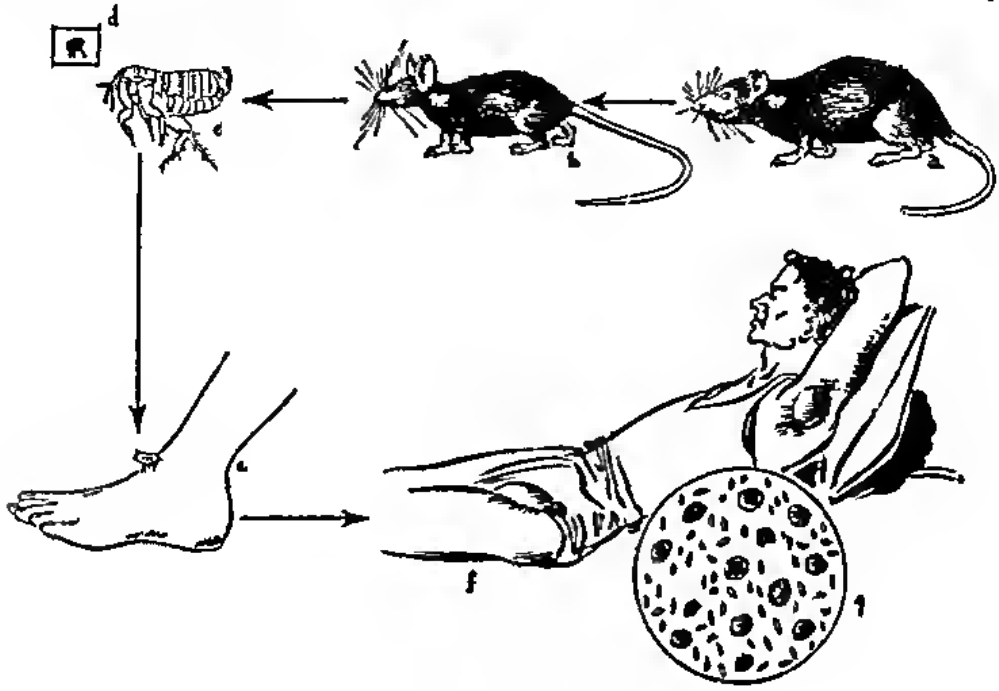
All observers agree that in bubonic and septicaemic plague, infection is through the skin. The primary bubo develops in the glands which are in direct contact with the lymphatics nearest the point from where the bacillus gains entrance. Varied experiments on guinea-pigs show that the bubo invariably develops in glands which are linked to the spot on which the infected flea has fed.

A new observation is made on the basis of knowledge gathered in field-work in villages around Bombay City and in the Punjab. The Commission finds that invariably a human epidemic is preceded by a rat epizootic. If the interval is measured by the occurrence of deaths, it is ten to fourteen days.

This interval has to be explained. It is found that the rat flea does not travel from infected rat to healthy man in a straight bee-line. Fleas deprived of food for more than three days and nights avidly and eagerly attack man in search of food. As long as there are rats, the fleas prefer them to men. The percentage of infected fleas taken from plague rats dwindles rapidly from the fourth day onwards. Putting these facts together, the Commission comes to the conclusion that rat-fleas become a source of danger to man after the third day of the disease in rats.

The incubation period for the plague bacillus inside man's body

adds three more days. The average time the disease takes to kill people after making an open appearance is another five to six days.



The plague circuit

(a) The brown sewer rat—victim Number One
(b) The black house rat—victim Number Two
(c) *Xenopsylla cheopsis*, the rat-flea, agent of transmission
(d) Natural size of the rat-flea
(e) Human leg—the usual spot attacked by the flea
(f) A plague patient with buboes in the groin and armpit
(g) Slide showing *Pasteurella pestis*, the plague bacilli

The Commission is convinced that the fleas prefer rats to human beings and do not attack men if there are enough rats. The natural host of the flea is the rat, and man gets involved in a disease which really belongs to the rat. Man is only an incidental in a tragic drama in which the rat and the flea play the principal parts.

Even when the flea jumps on man, it takes some time before it feeds on him. Human carriers have been known to transport infected fleas from one place to another without themselves being infected. In the new place the new population of rats attracts the flea.

Now the life-cycle of the flea engages the attention of the Commission. It is found that a rat-flea, when denied food, does not survive longer than a week; fed on human blood, it ekes out an existence of three to four weeks.

The scientists begin a systematic study of the rat-flea and obtain interesting data.

The flea sucks the blood from the wound it makes by the aid of

the pricker and passes it down its gullet by successive waves of muscle contractions. The stomach of the flea is a pear-shaped organ occupying a considerable part of the abdomen, and is guarded by a valvular arrangement. It accommodates as much as 0.5 cm. of blood at a time. A plague infected rat on an average carries a hundred million bacilli per cc. of its blood. From this is computed that a rat-flea can store up no less than five thousand germs at a time.

Yet another experiment on fleas is undertaken. First, fleas are fed on a plague infected animal and then fed on successive days on healthy animals. Each day a number of fleas are dissected and their stomach contents closely watched. Abundant bacilli are found up to the twelfth day, in one instance up to the twentieth day. The conclusion is apparent: plague bacilli multiply inside the stomach of the flea. The proportion of the fleas which permit this is larger in the plague season than during the rest of the year. Even this goes under the measuring rod: the number is six times greater in the epidemic season. During non-epidemic months no flea is found to carry plague bacilli after the seventh day ; even on the first six days, only five out of every hundred carry the bacilli.

The microscopic lens now focusses on the infected blood sucked by a flea. What happens to it? At the end of the digestive process inside the stomach, it passes on to the rectum of the flea in the form of a thick, dark red, slimy mass and appears at the anus as minute, black or deep red, tarry droplets, teaming with virulent plague bacilli. The flea itself is none the worse for the bacilli.

The Commission observes that the plague bacilli are rarely found in the gullet of the flea, and that only when the flea is dissected immediately after its feed. The salivary glands are equally free. The only organ to which they are traced in abundance is the stomach. The bacilli multiply inside the stomach of the flea and are thrown out through its faeces in order to relieve the choking overflow of the new generation of bacilli. When the flea bites a healthy animal, it makes a wound with its pricker on the skin. An interesting side-light on the mystery is the discovery that the flea has a habit of squirting blood from its anus, as it sucks fresh blood through the pricker. Even when you avoid rubbing the itching pricker-wound, there is a good chance for the bacilli to slip into the body.

This of course does not take into consideration the possibility of infection being carried on the contaminated pricker or by regurgitation from the over-loaded stomach of the flea.

The Commission finds that the male and female flea are both

capable of perpetrating plague murder, but infection through the bite of a single infected flea is believed to be a remote possibility

The Commission is not prepared to convict every variety of flea for the crime of passing the plague bacilli It is satisfied that the ordinary fleas on man—*pulex irritans*—can be given the benefit of the doubt so also *pulex felis*, the common flea on cats and dogs

But what about man as an accomplice in this murder game? Is a man suffering from plague by himself contagious?

Pneumonic plague cases are universally accepted as highly contagious, and stringent regulations for their isolation and treatment are legitimately prescribed

Then what about an ordinary bubonic plague patient?

Scientists have a surprising answer 'The safest place in a plague epidemic is a hospital' They find that plague hospital attendants are singularly free from infection

The Commission tests this theory by elaborate experiments Guinea pigs are allowed to have the freedom of the acute plague ward of the Maratha Hospital in Bombay A week of intimate carousing with the plague patients produces no untoward result

Bedding soiled just before death by the excreta of acute plague cases is placed in the flea proof room where fifteen healthy guinea pigs are living Each day, for several weeks, a fresh soiled bedding is brought and supplied to them But the guinea pigs are not affected by it

The Commission arrives at the conclusion that an imported plague patient by himself is not a source of danger, provided fleas are kept out

In further support of its opinion the Commission points out that its investigations into 'plague houses' are revealing There is no such thing as a house which can be called a reservoir of infection year after year Statistics show that a single case in a single house is the general average Multiple cases in the same house definitely give a history of simultaneous infections, with a heavier mortality in the rat population

This supplies a further link in the chain of investigations The conditions which favour the existence of a rat population are the essential prerequisites of a rat epizootic Insanitary conditions, open sewage gutters, open drains, garbage heaps, ill ventilated, overcrowded filthy localities breed rats Rickety structures, lofts and collections of junk, store houses, godowns, stables, cattle, goats and sheep with their refuse in the living rooms or court yards of man's habitation—

all these provide a wonderful meeting ground for rats. All that is needed to spread the epizootic is a rat who is a carrier. And such rats have been traced. For all practical purposes they behave like healthy rats, but harbour living and virulent plague bacilli in chronic abscesses. When the plague season arrives, the fleas march to their nefarious trade in rat lives. The human epidemic is then only round the corner. The poor naturally suffer more from plague than the rich. Habits of cleanliness and sanitation must be afforded in terms of hard cash before one can indulge in them.

The Commission points out that the plague bacillus very soon dies in the soil or on floors. The longest period, after gross contamination, is never more than twenty-four hours. It has no substantial existence in nature outside an animal body.

Rat-fleas can travel from one place to another in one of three ways: (1) on the natural host, the rat, (2) hiding in merchandise—hay, cotton, grain; or (3) on a human being.

Conditions which govern the rise and fall of a rat epizootic or human epidemic have been explored. Temperature considerably affects the flea's power to infect. 70°F is very congenial; 85°F and over is fatal to the bacilli in the flea's stomach; at 50°F, infected rats die before the bacilli appear in their blood, so that the storehouse for further infection is non-existent.

A high temperature is found to affect the breeding process in fleas themselves. It restrains the adult flea from depositing eggs, and deters the development of eggs into larvae.

Similarly the breeding of rats is vigorous during the off season which precedes the breeding of fleas. From this it is easy to see why plague is a seasonal disease. First, a rat epizootic reduces the rat population considerably, leaving the immune rat proportion greater than the susceptible rats. The immune rats now begin to multiply and bring into existence a new race of susceptible rats. The fleas are breeding, and as soon as the carrier-rat has crossed the path of a procreating flea, the epizootic begins. And after the epizootic, when the fleas have not enough rats to feed on, comes the turn of man and his epidemics. Plague comes and recedes automatically every year, unless we break the vicious circle of rat-flea-man-rat-flea and man again.

Yours affectionately,
MASHI

LETTER XX

LINA AND VIJAY,

Out of seeds come the plants and the flowers; out of theoretical experiments come the practical measures for preventing and curing diseases. Sometimes a seed is sterile; it belies the high hope that the reaper nourishes in his heart when he sows it. But even the crippled seed serves a purpose in the scheme of agriculture; it helps to keep man working at the soil, so that the other seeds may ultimately prosper. Each scientific experiment cannot be expected to unravel the Gordian knot; sometimes it side-tracks or holds up the inquiry in a bog for a time. But the spirit of research keeps the torch burning, and even if a cure cannot he located at once, prophylactic measures are sufficiently indicated to avoid the disease in the future.

For a long time, the cure for plague defied the best brains in science, hut the preventive measures were soon specified, and helped to keep the dissemination of plague under considerable check, even to push it back from the Continent of Europe.

The prophylaxis against plague is carried out in three distinct ways: (1) by segregation of the victim; (2) by sanitary measures against the rat and the flea; and (3) by protective measures by each individual.

One must not forget that in all these measures the basic factor is the people. Without the aid and close co-operation of the masses, success is impossible.

Segregation

As a rule all plague cases must be isolated in a separate hospital, which must be made flea-proof.

Schools, theatres, and places of congregation must be closed.

Everything which has been contaminated should be satisfactorily disinfected or burnt. Plague corpses must be disposed of according to sanitary considerations. They can be burnt or buried in deep pits.

Physicians, nurses and attendants looking after pneumonic plague cases require a complete equipment of overalls, hoods, gloves, goggles, plastic face-pieces and cotton wool or muslin masks.

Seven days of quarantine and the closest watch must be enforced on all contacts of the patients.

Cats and dogs will have to be removed from the presence of the infected.

Sanitary Measures

Natural harbourages of rats, like garbage, refuse and junk must be removed, and insanitary dark ill-ventilated houses without plinths pulled down and cleared. Rat-proof houses are a necessity of a safe civilized life.

On plague appearing in a village, the population must be prevented from fleeing without a plan and thus spreading plague in new centres. Plague victims must be located in hospital. Then the rest of the village can be moved to a new site. The old village must be thoroughly disinfected with special insistence on the extermination of the rat and flea population. Campaigns against the increase of the rat population will necessitate the setting up of traps and poisoned baits. Rats multiply at the rate of nine to fourteen per female rat, per breeding season, which may be twice a year.

A novel method has been suggested by Jean Danysz, the Polish pathologist from Paris. An epidemic disease other than plague, and not communicable to man, is to be set up among rats by the introduction of a bacillus discovered by him. But the whole thing is in an experimental stage.

Another quaint method is to catch rats, release the male ones, but destroy the females. The scarcity of females causes blood-feuds and perpetual fights amongst the remaining males—a veritable Kurukshetra battle of mutual extermination.

Health authorities must continuously dissect rats found dead in houses or streets in order to check up on the first appearance of a rat epizootic. The compulsory ' death-certificate ' is a valuable measure to locate infected houses and localities.

' Cyanogas ' is a light powder which gives off hydrocyanic acid in the presence of the slightest moisture. It can be distributed by a blower inside the nests and burrows of rats, and is fatal for both rats and fleas.

Methyl bromide can be used with advantage in the burrows made by field rats. Ships entering harbour must be closely watched, especially ships arriving from ports in contact with an endemic focus. Rat-proofing of ships, special gadgets to prevent rats going up or coming down the ropes which secure ships to the wharves, fumigation of ships by cyanide gas, and the disposal of all dead rodents at high seas before harbour is entered, are now accepted as routine measures by every steamship company all over the world.

Kitasato claims that convalescents from plague can carry the bacillus for at least three weeks after the cessation of the active disease.

Quarantine measures will therefore require a month's isolation for all plague patients even after recovery.

Individual Protective Measures

Face to face with an epidemic, immunization measures of all persons who have to stay on and work in the locality, must be undertaken.

Otten

All persons working in houses or areas where infection is likely to be harbouring, must be made to wear high boots, tight collars, closed sleeves and must he debarred from shaving.

A killed vaccine containing two thousand million bacilli per cubic centimetre makes a subcutaneous injection of great value. It renders effective immunity for at least six months. Haffkine introduced it. He used a six weeks' old culture of plague bacilli incubated at 25° to 30°C and killed by heat at 65°C for one hour with an addition of 0.5 per cent carbolic acid.

In 1927 ninety thousand persons were inoculated in Uganda with a similar vaccine prepared at the Entebbe laboratories.

Yersin, Calmette and Borrel have prepared an anti-plague serum. They immunized a horse by intravenous injections of living virulent cultures and produced the serum. Yersin's serum and Haffkine's vaccine make an ideal combination for all plague attendants to secure immunity.

Otten and de Vogel, experimenting in Java, evolved a method of prophylactic inoculation with a virulent, living plague bacilli, which is claimed to be superior to the vaccine of dead cultures. Between 1935 and 1941 excellent results were obtained in no less than 2,363,642 inoculations.

Girard has reported success with living vaccine in Madagascar.

The Pasteur Institute has prepared a dead plague vaccine which is freely used in Indo-China.

In French West Africa a lipovaccine, prepared with vegetable oil, and an aqueous vaccine prepared with water, are used.

Let us now find out what is the best treatment for a plague patient.

We begin by treating the symptoms, avoiding depressant remedies

Tannery worker and child.
Ellore, Andhra

Starvation and disease. This mother, begging in a Delhi street, is an agricultural labourer deprived of work following the drought of 1947 in Amraoti District

of all kinds. Headaches and high fever may be relieved by ice-bags. A lowering of temperature can be effected by an hourly sponging with warm water. Vomiting can be tackled by calomel followed by saline. In cases of collapse, stimulants are helpful.

Painful and hard buboes can be treated with glycerine and belladonna, or poulticed when red and inflamed. Cutting open the bubo and dressing it with iodoform is permitted when the bubo has softened. Some physicians advocate injections of iodine, camphor and thymol inside the buboes, or intravenous injections of iodine alone. Yersin's anti-plague serum, given intravenously and in large doses is recommended.

Haffkine

Mercurochrome 220 soluble is another intravenous injection which has healing power, especially in septicaemic cases.

Omnadin is injected in Java in pneumonic plague cases with considerable success.

Bacterio phage (Pestifage) was first recommended by d'Herelle, and a potent anti-phage serum was prepared and used in India, but the results are not promising.

Sulfadiazine and sulfathiazole have been found to be extremely useful in the treatment of plague. Attention to the fluid balance of the body is particularly necessary during their use.

Schutze tested the efficacy of sulfanilamides against plague infection in rats and mice, using them successfully by mouth and subcutaneously.

Prontosil Soluble Rubrum injections, to be given intramuscularly, are recommended by Carman.

Man is at last master in his little world, and has evolved many an instrument with which to fight off the pest.

Yours affectionately,
MASHI

LETTER XXI

THE PRISON FOR INFECTION: QUARANTINE

LINA AND VIJAY,

I shall relate to you the history of quarantine as practised in ancient times, and the place it occupies in modern civilization.

Twenty-three hundred years ago, plague breaks out in the city of Rome. Panic prevails. The Senators get together and send messengers to Epidaurus for guidance. Aesculapius sends back with the messengers a sacred snake. Once on the River Tiber, the snake

The snake arrives on a ship on the River Tiber
—Engraving after a coin of Antonius Pius

stealthily slips out of the ship, and swims to one of the islands. This is interpreted as a sign from the gods that the people must abandon Rome, and live on that island till plague disappears. All the healthy Romans set sail for the island, and as a mark of gratitude build a temple on the island. Soon the epidemic disappears, the island is deserted, but the temple remains.

This story is the first recorded instance of quarantine in modern history. It clearly expresses the idea that when an epidemic sweeps the country, isolation must be imposed on the people living in the zone where the disease has broken out. Infection must be cordoned off.

Coming nearer to our times, eleven hundred years later, we find St Othmar erecting a 'Hospitiolum' for lepers, segregating them from all other healthy people. His example is followed in the year 786 by the great King Charlemagne. He proclaims stringent regula-

tions for lepers. They must live only in specially marked houses; they can go out only on special days, and must live on charity by begging; when out on the streets, they are compelled to wear a black

Temple of Aesculapius

hat with a white brim and a black cowl with two white hands portrayed on the chest; they are forced to carry a horn and announce

their arrival by blowing it; they must be treated as social parials with not a single civic right to exercise. The lepers soon come to be known as the 'horn-brothers'.

Leper's rattle

In the eleventh century, a leprosy epidemic sweeps Europe. We find evidence of 'leprosaria'—leper homes—not merely in the big towns, but also spread over rural areas. The number goes on increasing, till, in the eighteenth century, there are nearly nineteen thousand 'leprosaria' in Europe. Edicts against lepers are made very strict. They are not permitted to enter inns and churches. They are not allowed to use public wells, and are forbidden to talk with healthy people. In a shop they cannot speak nor touch any commodity; only with a stick may they point out to the shop-keeper the object they want.

Then the 'Black Death' plays havoc with the fourteenth century. Isolation of patients is naturally the first thought that strikes doctors as well as laymen. Harbour after harbour on the Mediterranean and the Adriatic coasts puts up barriers against infection from incoming ships. Venice and Genoa refuse to allow any immigrants from plague-infested districts. Medical men, led by the famous Variguana, declare that the 'Black Death' can pass from man to man only by contact.

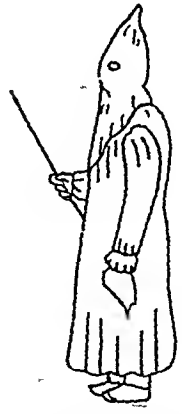
Saint Othmar
—Woodcut, Fifteenth Century

In 1374, Viscomte Bernabo of Reggio pronounces his historic edict of quarantine against plague. This edict lays down the basis of quarantine as it is practised today. The edict declares that every plague patient is to be promptly removed outside the city and left in the fields to get well or die. All contacts of the patients are to be isolated for ten days before they can move freely in society. The clergy is made responsible for reporting all plague cases to the authorities. Nobody can nurse a plague patient, except those specially selected for the task. A traducer of the edict is to share the fate of those who introduce plague in any area: confiscation of all property and the horrible death by burning at the stake.

In Ragusa on the Dalmatian Coast, the edict prescribes a thirty-day isolation for all healthy persons coming from a plague-area. In

Group of lepers
—*Pisa frescoes*

Marseilles, the period is raised to a forty-day isolation, thus interpreting literally the meaning of the word quarantine. The figure forty has somehow been considered auspicious throughout the Christian medical lore. The human embryo is believed to develop in forty days; women in maternity observe a forty days' ritual; according to the Bible, the flood lasted forty days; the alchemists need forty days for their transmutations; and the ancient physicians assert that an acute form of disease becomes chronic if it touches the forty-day limit. So forty days of isolation are declared sufficient protection against the worst disease.



Doctor's robe and hood, *Marseilles epidemic* 1819

Before the introduction of quarantine, diseases such as plague created great panic and a general stampede among the population. Ignorance regarding the cause of the different diseases and the best way to fight them, lead some men to clutch at quarantine blindly, as it leads other men to oppose it.

In the sixteenth century, when plague is taking a heavy toll from Milan, the prison inmates remain safe. Isolation from infection is the cause of the immunity. But the doctors of the day have another explanation to offer. They say that odours from the night-soil kill the 'Plague air' when the stinking prison-rooms are opened every morning.

Doctor's leather overall and mask (1721)

In 1830, the Czar offers a prize for the best essay on 'The Nature of Cholera'. Many competitors write against isolation of cholera patients, and attribute the cause of the disease to 'fear of cholera'.

Towards the end of 1831, a young enthusiastic twenty-seven year old medical man is posted at Danzig to save the city from a cholera epidemic. He keeps a diary of those sad days. George Stromeyer writes: 'Whoever wishes to isolate himself, may do so, but he should not demand that thousands of people become miserable to please him. Isolation is a good solution, but an impracticable one.'

This is one kind of objection to the quarantine system. The other arose from ignorance and superstition.

I shall quote a glaring example. A responsible medical journal—Huzeland's journal of 1839—reports two cases to prove the course supposed to be adopted by plague to infect innocent people. 'An Arab woman, belonging to a family which was nursing a plague patient, hung out her cloth to dry in the sun. A wayfarer touched the cloth and was infected with the disease!' In the second case, 'A boy lived in a house in which there was a plague patient. One day he went to the roof of the house to fly a kite. A passing bird touched the string of the kite, and thus became a carrier of the disease.' The writer concludes: 'Isolation and quarantine are useless, because the contagion is so powerful that even a chance touch can spread the disease.'

As against this blind opposition to quarantine, we have the illustrious example of the cities of Milan and Bale. Milan passes an edict in the year 1576, which punishes anyone entering the city without a health-pass; you run the danger of death if the extreme penalty of law is meted out to you. All travellers and journeymen are barred entrance to the city. No one is allowed to loiter or beg on the streets. Even movement from one house to another is forbidden at one time;

a single male member from each family is permitted to go out shopping once a day. Taverns are put out of bounds. When the plague epidemic declines, women and children are allowed to go to church, but people living in an infected house are subjected to disinfection of all clothing continuously for a fortnight. Officials go the round of every family making detailed inquiries about the health of every single member.

Between 1050 and 1670, Bale has twenty-six visitations of plague. In 1667, the first preventive measures are undertaken. All trade is brought to a standstill. An open space at some distance from the city is made the dumping ground for everything required by the citizens. A vessel of boiling water is installed on the border in which money is to be thrown by the customers. Anybody leaving the city has to undergo disinfection by fumigation. The first protocol of the Council declares that all infected houses are to be vacated. All victims of the epidemic have the option of being shifted to an isolated place or to the topmost floor of the house, where the patient and his attendants are both to be isolated. It is compulsory to disinfect all rooms and their contents with lime. Prominent doctors are appointed to supervise the observance of these regulations. All plague corpses are scrupulously removed, and their belongings burnt. The whole family of the victim is placed in quarantine. Bale saves itself by these ruthless measures.

The Quarantine
—Etching by Daumier

Many other cities enforce regulations of a similar character. Health-passes specify the places you have visited, and whether those places are free from epidemics. River-crossings become the focal points of the closest scrutiny. All postal-letters are fumigated; the postmen are forced to travel along marked routes only. Fairs and markets are postponed indefinitely; all commodities are compulsorily disinfected. Special uniforms for physicians and surgeons as well as grave-diggers are prescribed. Furs, hides, hair, cotton, feathers, hemp, flax, silk and wool come under the 'dangerous' label. They are suspect as sources of infection. Many fumigants are on the market.

Ambroise Pare, the famous surgeon of the sixteenth century, has his own special prescription: White wine, absinthe, sage, gardenia, angelica, gentian, and rose water. Sulphur and antimony are also used.

Whole countries isolated themselves from the fear of plague. In the eighteenth century, Prussia puts herself into quarantine for one and a half months because of the danger of an epidemic in Poland. The plague in Greece sends all its neighbours into quarantine. The plague in Marseilles in 1722 frightens the Parisiennes into placing a military cordon round their city. All European ports are declared closed to French ships as long as the epidemic lasts. Marseilles itself imposes from time to time a quarantine period of eighty to a hundred days on all ships entering the harbour.

In 1830, Russia and Austria put double cordons of troops at all their frontier stations, and quarantine-houses are made available on the main roads throughout the countries. All ships are subject to a forty-day quarantine; St Petersburg observes a fifty-one day quarantine period. The law enforces disinfection of all houses and reporting of every suspicious case to the authorities.

Six years later, the Treaty of Adrianople recognizes twenty-one ports in different countries as quarantine-stations for all ships. In 1892, an International Quarantine Convention is signed at Venice. Since then a dozen conferences on an international plane have met. The Suez Canal receives its quarantine regulations because Europe wants to be protected against the contagion from the yearly pilgrimages to Mecca.

In 1907, the Rome conference sets up an International Bureau of Public Hygiene. The Convention in 1920 lays down a scheme for mutual information by the signatories about plague, yellow fever and cholera. It includes a report on precautions taken against the commencement of an epidemic. Each signatory promises to see that the ships leaving its ports are not carrying infected cases. Supervision of land frontiers, coastal and river traffic, the Red Sea, the Persian Gulf and the Hedjaz pilgrimages are carried out.

In 1926, the Paris conference adopts similar measures against typhus and smallpox.

We have today precise regulations for making ships, docks, and warehouses rat-proof. Rat extermination is compulsory every six months as a routine measure. The yellow quarantine flag is introduced for all infected ships, and cannot be lowered until the port quarantine officers sanction the landing of passengers and the release of the ship. The port doctor receives, as a matter of routine, the

report of the ship's doctor on the cases considered infectious. Such cases are classified under one of three heads: (1) to be isolated on board-ship; (2) to be isolated in a quarantine station; (3) to be under surveillance, where isolation is unnecessary but a watchful eye is kept on the subsequent health of the invalid. A ship reporting even a single doubtful case is subjected to disinfection. The luggage that it carries also receives attention, and must be freed from insects and microbes of every kind. The codes of the International Sanitary Convention are now made applicable to all maritime ships as well as to air traffic.

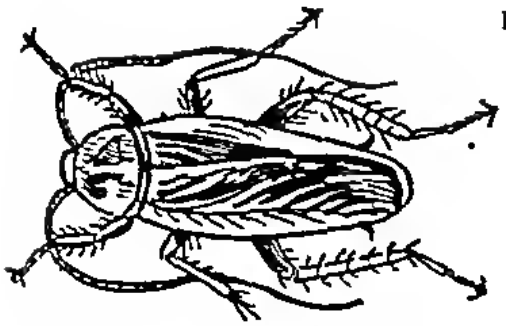
The tendency today is to avoid extreme and panicky measures which unnecessarily interfere with trade and commerce. Emphasis is put on disinfection, reporting of cases, a qualified staff to tackle all invalids, doubtful or otherwise, and quarantine when absolutely necessary. The International Health Office which used to function from Paris before the beginning of the last World War acted as a clearing-house for all relevant information on five main diseases —cholera, plague, yellow fever, typhus, and smallpox.

The growth of quarantine has become phenomenal. Take the example of the U.S.A. It supervises and guides quarantine regulations in fifty-two ports of America, forty-one air-ports, thirty-three land junctions, seventeen frontier outposts, over and above the whole Panama Canal Zone. Its officers are attached to nearly forty foreign consulates to keep a sharp eye on the immigrants entering the country. It is a vast network of specialists. Quarantine is duly recognized as the first requisite for a healthy nation.

We are surrounded by invisible enemies on every side. The air we breathe, the water we drink, the food we eat and the dust that settles on every object we touch—through all these agents, microbes of known and unknown potentiality are ready to attack us.

One way of avoiding a particular species of these invisible enemies is quarantine. Keep away from infection, live under controlled conditions regarding food, clothing, water and air, where special measures against the particular species have been undertaken, and you are safe against the spread of a prevailing epidemic. Quarantine is no cure of a disease. But it is based on the theory of checking the spread of the disease. It tries to kill the enemy by isolating it and circumscribing its nefarious activities, by surrounding the microbe with conditions which make living and breeding very difficult, if not impossible.

INSECTS THAT WORRY THE DOCTOR



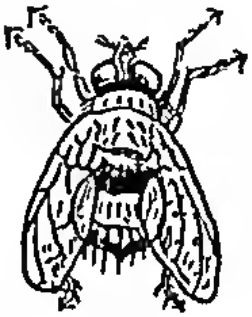
Cockroach

Spring-tail

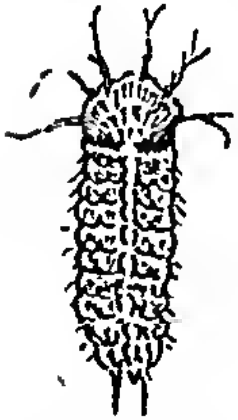
Blister beetle

The world is wide, and social conditions very varied. Principles of sanitation are not practised in the same measure everywhere. Epidemic diseases invade different countries from time to time. Travel has become swift, and soon will be swifter. Transportation of diseases is easier too. In these circumstances, quarantine regulations, intelligently functioned by an efficient, trained personnel, assume wider and wider importance.

Yours affectionately,
Masih.



Blow-fly

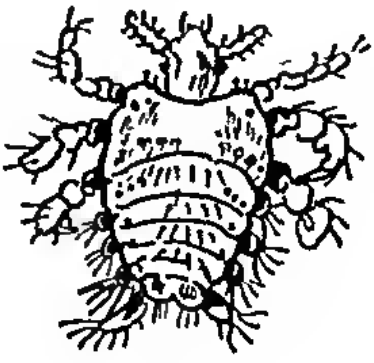


Pus caterpillar

Bed bug

Flea

May fly



Pubic louse

Ideas have never conquered the world as ideas, but only by the force they represent. They do not grip men by their intellectual contents, but by the radiant vitality which is given off from them at certain periods in history ... The loftiest and most sublime idea remains ineffective until the day when it becomes contagious, not by its own merits, but by the merits of the groups of men in whom it becomes incarnate by the transfusion of their blood. Then the withered plant, the rose of Jericho, comes suddenly to flower, grows to its full height, and fills all the air with its powerful aroma.

—ROMAIN ROLLAND
in *John Christopher*

LETTER XXII

NO LONGER THE DISTANT GLOW

LINA AND VIJAY,

My aim in writing these letters is to find you a foothold in the mysterious land of the microhe-world. Like Columbus, we have wandered over the wide oceans in search of land, a haven of safety for people tossed hy turbulent storms of epidemics. Columbus found America, a tiny bit nf a whole new continent. We have not merely found tlie new world of microhes, but have landed on the shores of the new continent, and scaled several mountain-barriers that at first seemed formidable and impassable. Today, we have knowledge about the root cause of many diseases. We have ideas which can no more he killed by attributing evil intentions to them. We have fashioned weapons to change this soul-destroying age, and make it possihle for man to be healthy—a first condition of heing wealthy and happy and gay.

You will remember that it was Rahoul's deep-seated grief that awakened my interest in medical science. I became a book-worm inside medical lihraries, and behaved like a microbe pestering doctors, in order to get a hetter understanding of diseases and their cures.

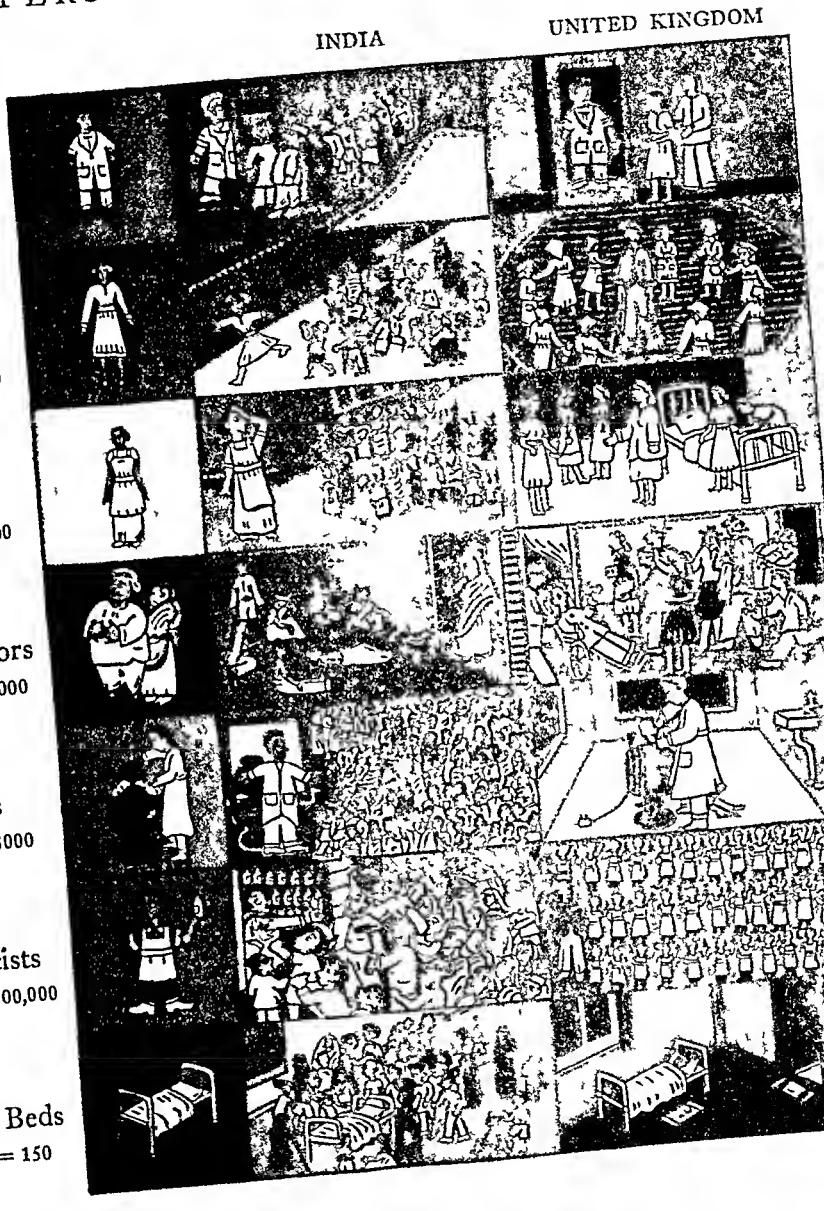
During my search, I realized for the first time the full depth of our deht of gratitude to the scientists for their wonderful achievements—men who struggled valiantly and gave us the invaluahle gift of not only controlling diseases, but effectively wiping them out from our midst. They have freed us from constant fears and inordinate suffering wreaked by the sleek invisible microbes that lurk in our food and water and air.

No longer do we have to turn to the medicine-man or faith-healer for succour. The many diseases under which our benighted ancestors quaked, which they attributed to the machinations of evil spirits, have become a thing of the past. The microscope has helped the microbiologist to peer at a world which the human eye was not made powerful enough to see, and thus bring to light real demons, the bacillus and the virus, with their deadly progeny.

I shall tell you of the work done by the microhinlogist in the last twenty years of the nineteenth century. It will give you a fair idea of our progress.

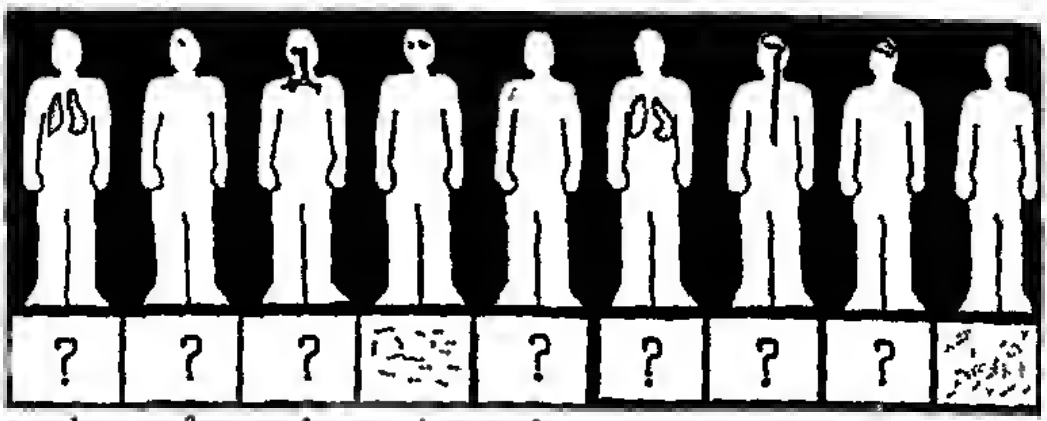
In 1880 Eberth finds the bacillus of typhoid fever. Ogston is close behind him with the staphylococci in 1881. Koch now takes the stage

COMPARATIVE FIGURES OF MEDICAL PERSONNEL AND EQUIPMENT

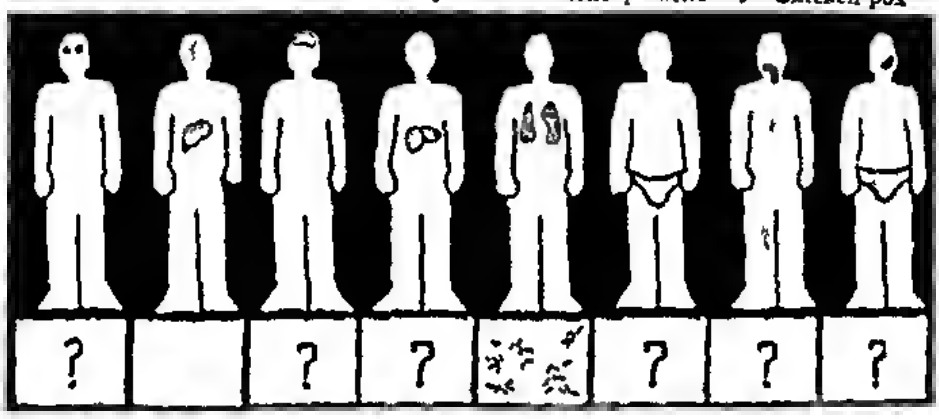


GERMS WHICH CAUSE HUMAN DISEASES AND THE LOCATION OF INFECTION

VIRUS

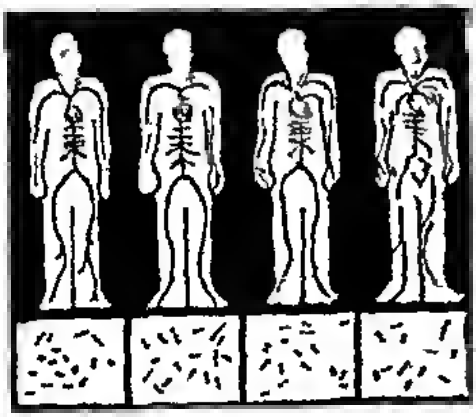


1 Ornithosis 2 Smallpox 3 Cold 4 Inclusion Conjunctivitis 5 Dengue
6 Atypical Pneumonia 7 Poliomyelitis 8 Encephalitis 9 Chicken pox



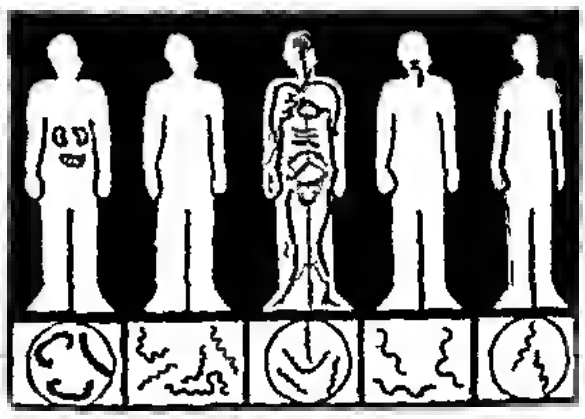
10 Trachoma 11 Yellow Fever 12 Rabies 13 Infectious Hepatitis
14 Influenza 15 Lympho granuloma venereum 16 Measles 17 Mumps

RICKETTSIA



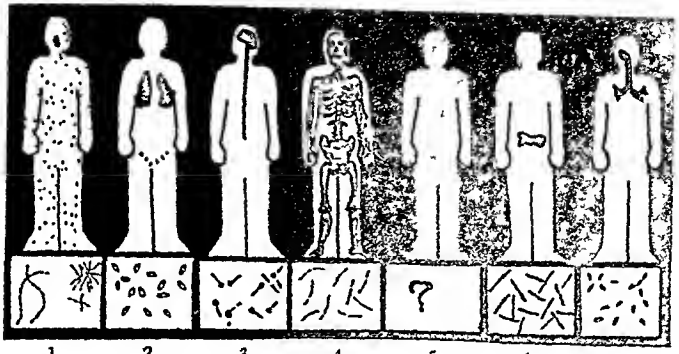
1 Epidemic typhus 2 Murine typhus
3 Scrub typhus 4 Rocky Mt Fever

SPIROCHETE



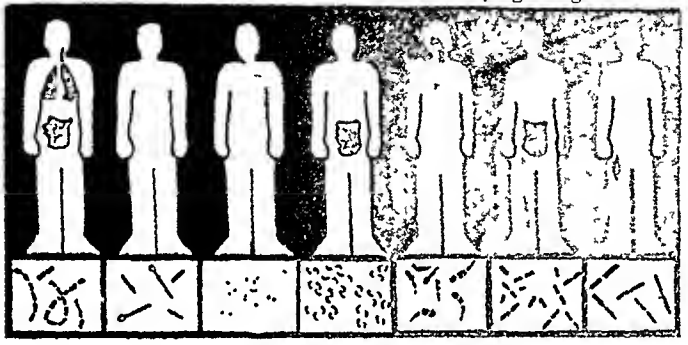
1 Infectious Jaundice 2 Relapsing Fever
3 Syphilis 4 Trench Mouth 5 Yaws

Bacillus



1 2 3 4 5 6 7

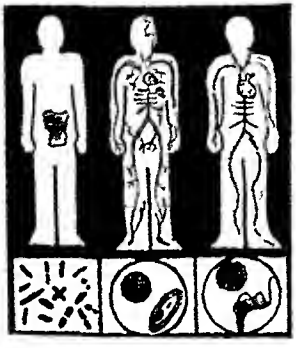
1. Leprosy 2. Plague 3. Tetanus 4. Tuberculosis
5. Tularemia 6. Typhoid 7. Whooping Cough



8 9 10 11 12 13 14

8. Anthrax 9. Botulism 10 Brucellosis 11. Cholera
12. Diphtheria 13. Dysentery 14. Gas Gangrene

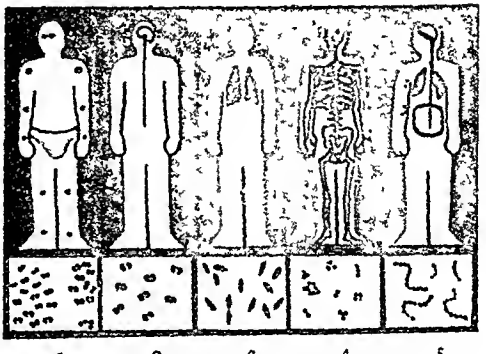
Protozoa



1 2 3

1. Amoebic Dysentery
2. Malaria
3. Trypanosomiasis

Coccus



1 2 3 4 5

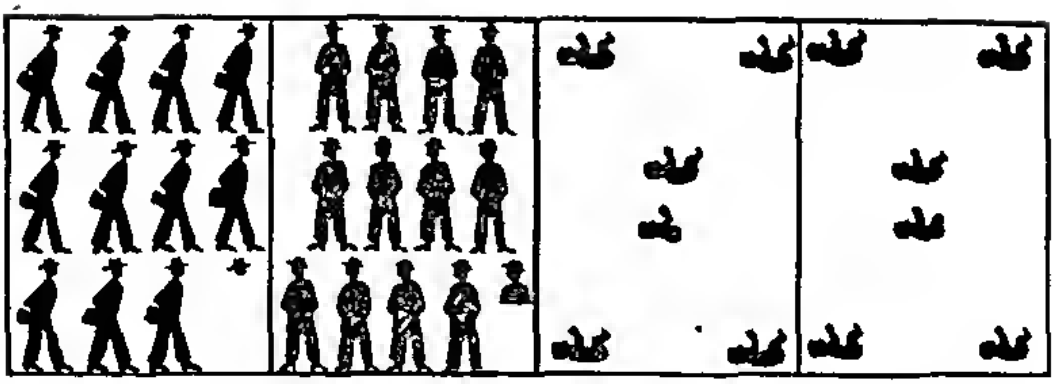
1. Gonorrhoea 2. Meningitis 3. Pneumonia
4. Staphylococcus 5. Streptococcus

—Adapted from a chart by Jerry Muscott appearing in 'Life', 5 November 1945

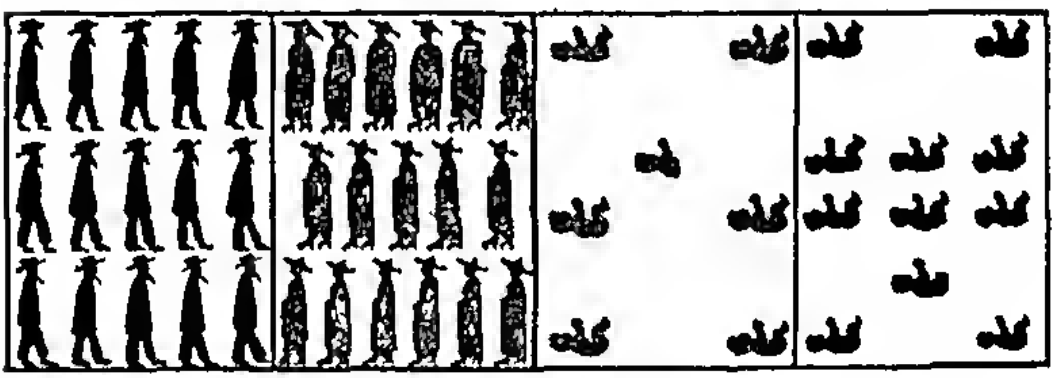
MORTALITY RATE IN 1937

ADULT
(Per 1000)

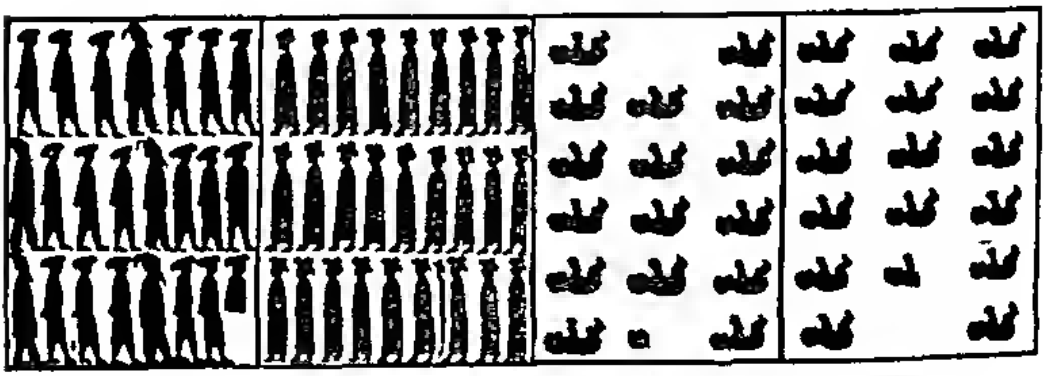
INFANT
(Per 100)



U.S.A. ENGLAND & WALES U.S.A. ENGLAND & WALES



FRANCE JAPAN FRANCE JAPAN



INDIA EGYPT INDIA EGYPT

with the anthrax bacillus, and proceeds to unearth in 1882 the tubercle bacillus and in 1883 the cholera vibrio. A year later, Nicolaier spots the tetanus bacillus, responsible for cruel death by lockjaw and continuous spasms of muscles. In 1885 Escherich unravels *bacillus coli* playing havoc in the blood stream, bile ducts and the urinary tract. Next year arrives Fraenkel with the pneumococcus, the germ of pnēumonia, and the year after that Weichsalbaum, carrying a tube full of meningococcus of brain fever. Side by side with him is Bruce, who finds out the cause of undulant fever, *brucella melitensis*. The year 1888 witnesses the discovery of the microbe which causes food poisoning with intestinal complications, when Gartner deciphers *bacillus enteritidis*. Another four years and Welch with Nuttall steps up and demonstrates the gambols of *bacillus Welchii* found in cases of gas gangrene. In 1894 Kitasato and Yersin simultaneously focus their microscopes on the plague bacillus. Before the nineteenth century is rung out, Van Ermengem gets on with research on the *bacillus botulinus* in 1896, thus finding out the reason why imperfectly canned foods caused death. Two years later, Kiyoshi Shiga, the Japanese scientist, locates *bacillus dysenteriae*.

The list is not exhaustive. It is meant to give you an idea of the age of research in which we are living. Thousands of scholars all over the world, in every country, are concentrating the eye-pieces of their microscopes on the microbe world. My object in citing these discoveries is to remove possible doubts that may assail you. In our present-day world, smart cynics are always seeking to poison unwary minds with the sole aim of establishing their own superior wisdom. They point to a case here and a case there—cases of individuals in the little world around you—and argue the general proposition: mankind has gained nothing from the medical discoveries of science! For them, science cannot heal at all; science has added more diseases. They affirm that science cannot promise an era when there will be no disease at all, science has no value for society as such.

I ask you to examine closely the arguments of these 'savages riding in automobiles'. When we turn the pages of history and compare the figures of mortality of by-gone days with our present age, we find revealing evidence. The 'Black Death' claimed twenty-five million lives in the fourteenth century in Europe alone. In 1665 the city of London lost one-seventh of its population in a matter of five months. Today the civilized world has shed its fear of plague. We have reached the stage of being that 'happy posterity' of whom

Petrarch dreamt, 'who will not experience such an abysmal woe', and look upon Petrarch's 'testimony' as a 'fable'.

Take smallpox. Boston and Massachusetts are good examples. They were unfortunate targets of the disease in 1752 and one third of the population suffered from its ravages. In the eighteenth century smallpox killed sixty million people. In the nineteenth century forty-two thousand deaths occurred in a single year in England. Today the dread of smallpox is non-existent.

Cholera is another instance. The people of London no longer have to drink polluted water and be victims of cholera as they were in 1854, when 2,050 died within a week and 6,005 within a month.

The period from 1875 to 1935 is a short span of sixty years. Yet the period before this is pre-Pasteurian, and full of dark pitfalls, when men had no aids against epidemics; the modern period is one of enlightenment, made safe by the discoveries of Koch and Pasteur and their pupils

Let us look carefully at the comparative table of deaths from diseases in England and Wales in the years 1875 and 1935.

	1875	1935
Enteric and Relapsing Fevers ..	8,913	174
Dysentery ..	746	116
Typhus ..	1,499	Nil
Smallpox ..	849	Nil

Remember that statistics were not exhaustive in 1875, but were very exact in 1935. These figures should convince the biggest dumb-ox-of-thought. And yet we find in our midst educated and intelligent beings, who scoff at the achievements of our age. They have the means and do not hesitate to take the fullest advantage of the benefits of science, and yet they have the temerity to advocate vehemently reactionary ideas: 'Civilization and progress have brought in their wake more diseases!' Will they be prepared to abrogate the amenities and benefits they enjoy as part of the heritage which science has secured for them?

Imagine for a minute, what would happen to the city of Bombay if medical protection were withdrawn. When we compare the loss arising from a suspension of the facilities provided by physical science to the one from medical science, the depth of the chasm becomes apparent. Physical science has provided the telephone, the telegraph, the railway, the aeroplane, the motor car, and electricity in the last hundred years. If they were removed, life would still go on uninterruptedly, though much more slowly than today.

If we remove the advantages of medical science of the last hundred years, civilization would be pushed back to the Dark Ages. It would not be a question of losing comforts and conveniences, of distance being eliminated, and labour saved; it would be a question of jeopardizing existence itself. Just consider the virulence of any single epidemic—cholera, smallpox, plague, malaria, leprosy, yellow fever. With the swift aeroplane, the railway and the steamship of today, the whole world would be infected in a matter of days. And all the relief you can expect is the kind prescribed for Charles II on his death-bed. You can ride in your motor cars and aeroplanes, and try to flee from the epidemic. But the disease would ride with you, unknown to you, in the vehicle provided by advanced physical science.

We enjoy the fruits of physical science *because* medical science has made the world safe for their use. Given the option, what will you select: an aeroplane doing a thousand miles an hour, or an epidemic of fatal pneumonic plague, without the knowledge of how it spreads and how it can be combated?

Let us look at the world. When we examine the vital statistics of countries with provision for medical safeguards, and others where they are yet in an elementary stage of organization, we find the answer very explicit.

In the U.S.A. the death rate in 1937 claimed 11·2 per thousand; in Japan it rises to 17; in our own country it is double that of the U.S.A.: 22·4. Look at the infant mortality figures. In the same year where the figure is 58 in England and Wales, it rises to 158 in Ceylon and 162 in British India. Look at the statistics which tell us about expectation of life at birth. Where the U.S.A. records an average of 60 years, British India hardly reaches 27 years.

Comparative figures for the available medical personnel and equipment in the United Kingdom and in our own country are revealing.

	British India	United Kingdom
Doctors	1 for every 6,300 persons	1 for every 1,000 persons
Nurses	1 „ „ 43,000 „	1 „ „ 300 „
Health Visitors ..	1 „ „ 400,000 „	1 „ „ 4,770 „
Midwives ..	1 „ „ 60,000 „	1 „ „ 618 „
Dentists ..	1 „ „ 300,000 „	1 „ „ 2,700 „
Pharmacists ..	1 „ „ 4,000,000 „	1 „ „ 3,000 „
Hospital beds ..	1 „ „ 4,000 „	1 „ „ 125 „

The ratio of death and disease is in direct relation to the use or otherwise of the aids provided by progressive medical science

But the cynic may turn round and say 'Why, even in England, you still find people dying of disease!' He is stating an obvious truth The thing to remember is that epidemics do not rage in England, and if by chance they do, they are instantly brought under control More people have a chance of a longer and healthier life than in our country, with its appalling lack of medical facilities

It must be remembered that medical science does not claim to cure all diseases It has not reached that point of perfection when it can heal every time any disease which attacks any human being Yet, it cannot be denied that medical science has progressed, has made huge strides forward, has unearthed the world of bacteria, and located several very virulent death agents

The menace of disease is definitely diminishing Epidemics are not a source of perpetual terror as they used to be We have every reason to be hopeful The future is full of promise

However this optimism should not be mixed up with the boasts of a Cagliostro of perpetual life All that science has put at our disposal are measures that will nip premature, unnatural deaths in the bud Death will still result, but increasingly as the inevitable consequence of old age The prophecy of Isaiah is the present target of the medical man 'There shall be no more thence an infant of days, nor an old man that hath not filled his days for the child shall die an hundred years old' The rosy vision of the prophet is only attainable, if we actively adopt the fruits of the scientists labours and give our full co operation to the valiant advance guard in the battle for health This must not be as an expedient in times of emergency, when an epidemic gets the community by the throat, but as constant sentinels of a vigilant bastion of defence against the invisible army of death spelling destruction—the germs of disease epidemics

Turn your eyes to the heart breaking loss of precious human lives in our country Most of it is preventible Here are some relevant figures

The daily loss of human lives in our country is as follows

Cholera	397	Dysentery and diarrhoea	718
Smallpox	190	Fevers	9,926
Plague	85	Lung and chest diseases	1,293
Other causes		4,382	

Every two minutes a human being dies of dysentery or diarrhoea

Every minute a person dies from lung or respiratory diseases. And every minute seven persons die from one kind of fever or another—mostly malaria, typhoid or pneumonia. The total deaths are twelve per minute, out of which nearly ten or eleven need not die, because they die of preventible diseases.

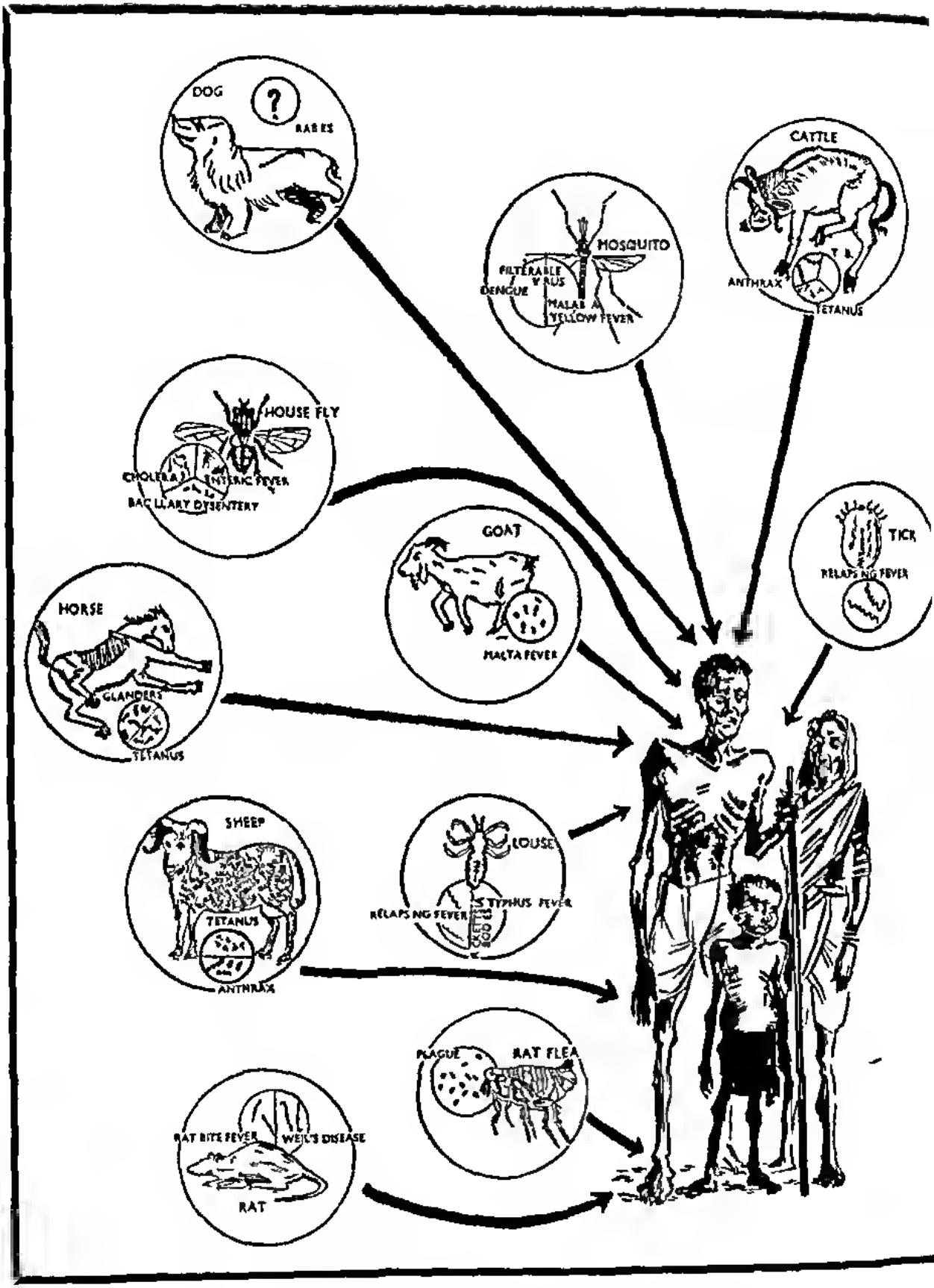
This dismal condition is the result of a dearth of medical aid in our vast land. The man in the street, toiling for his bread, is vouchsafed 'freedom'—freedom to catch innumerable diseases and die unaided! We have an unbalanced social system that heaps doctors and drugs at the doors of a few, and a lack of both in the houses of the vast majority. Our unjust economic system reduces the toiler to poverty in the midst of plenty. It denies man his fundamental and primary needs of health. Wanton competition and trade in the fruits of medical science are permitted, with the result that the profit-motive governs quantity in production. We work a lopsided plan that befouls the right to health of the whole population. This supreme chaos is our society.

But we need not despair. Our age is renowned for its scientific and technical discoveries. Science itself can quicken the pace, and function as a dynamic force to radically alter the present structure of society, so that man with his selfishness and individual interests will not be an ally of disease, but its avowed and active enemy.

We have before us the examples of Europe and America, especially of Soviet Russia, where civilized people have successfully harnessed scientific and technical discoveries to the task of improving and safeguarding the health and happiness of the downtrodden suffering masses. Soviet Russia appeals to us more, because of its colossal Asiatic base and problems so similar to our own.

The gigantic upheaval of 1917 pushed Russia out of the vicious rut in which the Csar's decrepit court had kept it. The old retrograde society was remodelled on scientific lines. In the short period of twenty-five years the country was transformed from crushed humanity to one pulsating with progressive activity and constructive aspirations. Let us briefly recapitulate the events before and after the Russian Revolution.

Wave after wave of epidemics that were endemic engulfed the vast land of Russia, whilst the Csar and the Csarina disported themselves in the company of the crafty Rasputin in the palaces of St Petersburg. The country was backward and sunk in the darkest despair. It had neither proper scientific knowledge nor adequate medical equip-



Sources of infection of some of the bacterial diseases

ment to effectively combat and control the visitation that regularly inundated the land year after year.

The accounts of horror reached Europe, and the people of Europe quaked with fear, because the Russian epidemics were sources of infection from which they could not remain safe for long.

The outbreak of World War I, with the mobilisation of fourteen million soldiers and the continuous inflow of refugees from war-affected areas, created new situations fatal for the peoples of Russia. The health authorities, seeing the enormity of danger, tried to set up some kind of organization. But the sluggish habits of an irresponsible bureaucracy, and inefficiency born out of these habits, made all organizations effective only on paper. They did not send aid where it was most needed, and so failed miserably to stem the onslaughts of infuriated Nature. It took them actually more than a year to vaccinate the soldiers against typhoid and cholera.

In 1915 an epidemic of typhus fever broke out on the Turkish front and was carried to Samara by the Turkish prisoners.

It was a war in the midst of a war, without the elaborate paraphernalia necessary for waging this much more dangerous war against Nature. Russia mobilized a corrupt and incompetent medical high command. To add to the confusion, the vast population was running helter-skelter in every direction with a morale shattered beyond redemption.

Now the blows from the enemy fell thick and fast. In the summer of 1917 scurvy made an appearance on every front. Typhus broke out again, this time in Petrograd during the winter. Seven months later, Russian prisoners from the hinterlands of Europe brought with them the dreaded influenza. Europe was paying back Russia in the same coin with which Russia had doled out epidemics to Europe generation after generation.

Typhus was once more on the offensive. Russia was sick in body and mind; the epidemics tortured the body as the civil war racked the mind. Life was terrible. Lack of transport facilities, depletion of supplies, the blockade imposed by the Allies, famine of an unheard of intensity—all these created conditions reminiscent of the Dark Ages.

Suffering now reached its zenith, when Lenin and his band of devoted workers took matters into their own hands and tried to combat disease. Lenin said, 'Either socialism will defeat the louse, or the louse will defeat socialism'. A Central Epidemics Commission was appointed to deal with the emergency. It had a herculean task to perform. People were starving and exhausted by the wars. They lived

in huddled groups and spread infection everywhere. Soap and fuel were unavailable even for disinfection purposes. But soon quarantine arrangements were provided at all important railroad junctions. A quarter million hospital beds were laid out for cases of infectious diseases. Millions of leaflets and posters were broadcast by the Propaganda Department. Lecturers toured the country with exhibitions-on-wheels. Railway passengers were detrained, forcibly bathed and disinfected, and only then allowed to proceed to their destinations. 'Bath Weeks' swept clean every nook and corner of towns and villages. Aeroplanes sprayed the land and sheets of water for millions of hectares. Twenty million metres of mosquito-netting was distributed to collective farmers all over the land.

A huge spider's web was woven with institutions specializing in varied health activities, to combat the epidemics—dotting every crucial junction where the roads crossed in the vast continent of Russia. The Russians battled against typhus and plague, relapsing fever and cholera, typhoid and dysentery, smallpox, diphtheria, scarlet fever and measles, rabies and anthrax and trachoma, and above all malaria. Single-handed, Russia struggled for existence with the rest of the world looking on with folded hands, and actually gloating over and inciting disorder and bloodshed instead of helping with vaccines and essential drugs. It is a sad chapter wherein man stood by and delighted in the death of man.

I propose to deal at length with the experiment in socialized medicine that the Soviets successfully worked out. I shall leave it to you to judge and draw your own conclusions whether it is fruitful and in our own interests to deal with Indian problems in the same fashion as the Russians. The builders of the future India must decide on it. But I do think there is a lot to learn in the phenomenal experiment of Russia.

Socialized medicine modulated to our needs and our conditions strikes me as the only solution of our task in India. Health will have to be a central subject, directed and planned for the whole country. It is more important than External Affairs, Defence, Finance or Commerce. Defence against disease is the first necessity of an army, however well-equipped and brave; industry and agriculture, the practice of the professions and the working of universities—all require the safety which thorough medical provision alone can secure.

Let us examine the road travelled by Russia, a country of vast spaces, thick population and inter-twined cultures like ours.

Soviet medicine does not tolerate business or trade in medical services and drugs. In Soviet Russia medicine is not a service which the

sick and the ailing can purchase at a private clinic or the shop of a chemist. No more can the doctor sell his knowledge of healing at a price. The system of competition has been abolished in the U.S.S.R. You are not permitted different scales of doctors' fees, as in all other countries. Nor are patent drugs allowed to be on the market—drugs whose components are not publicly declared, and in many cases prove to be spurious. The law of demand and supply cannot operate in the U.S.S.R. for adding to the private fortunes of physicians and pharmaceutists.

Soviet medicine has another characteristic feature. It does not distinguish between curative and preventive branches of medicine. It has built up its huge network of health organizations and services on the principle of prophylaxis—the idea of prevention dominating the whole medical organization. The constitution of the country lays down in specific words the task of the People's Commissariat of Health: '... responsible for all matters involving the people's health and for the establishment of all regulations promoting it, with the aim of improving the health standards of the nation, of abolishing all conditions prejudicial to health.'

This is a revolution in itself. In Csarist Russia, out of every rouble of the health budget, 95 kopecks were spent on general treatment and only five kopecks on prophylaxis. In the United States, the ratio between the curative and the preventive side is as thirty to one. The U.S.S.R. spent three-fifths of its health-budget on preventing diseases even as early as 1920. Today it is impossible to compute the proportion, because the distinction between curing and preventing diseases has become non-existent. Every physician is also a health worker, interested in sanitation and preventive medicine.

The principle on which the medical man works is that health is to be safe-guarded all through the life of every individual. He must be medically supervised in an unobtrusive, inoffensive, wise manner, without unnecessarily interfering with his normal avocations. Trained doctors keep a vigilant eye on him at every phase of his life: when he is in embryo in the womb of his mother, at the time of his birth, throughout his childhood and adolescence, when he joins the factory as a worker, or later when he retires due to old age.

The physician is like any other worker in a land of workers. He is an expert, with health as his principal passion, just as the engineer is interested in road-making and bridge-building. He labours to fulfil the general plan of society, shoulder to shoulder with the rest of the workers. The doctor is an instrument of society, created and maintained by it, to safeguard its health.

The health philosophy of the U.S.S.R. is simple and basic: Every man must work; it is his duty to work for society in order to keep the whole community happy and fit. If he falls ill, he cannot fulfil his quota of work, and would be an anti-social element if he languishes in his illness; it is his duty to get well as quickly as possible. On the other hand, it is the duty of society to keep him fit for work; disease will come in the way of his performing his allotted tasks. So the state —which is only a working committee put up by society to plan and execute everything essential for its existence—organizes health for everybody with every means available to it to prevent and cure diseases. Just as it is the duty of the state to provide health facilities, so must every comrade fulfil his duty by taking advantage of health facilities. To be the source of spreading disease is a criminal offence against society. Health is not merely absence of disease; health is the enjoyment of life—with man in control of nature—a positive achievement.

Let me cite here the four basic pillars on which the whole structure of socialized medicine is raised:

(1) Fruits of medical science are not commodities in which barter or trade is permitted; they are public property, used by the public, for the public.

(2) Facilities for treatment are universal, without any charge, and decided upon by the technical medical experts according to the medical needs of each case.

(3) Prophylaxis on the principle of 'prevention is better than cure'.

(4) Health is fully planned and centrally directed by the People's Commissariat of Health: every doctor, pharmaceutist and chemist is a part of the conscious structure erected by society in its comprehensive health plan.

The Soviet health service is financed from the resources of the state and from social insurance funds.

Social insurance is so widespread that it covers every worker in every field. The trade unions operate social insurance by electing delegates from amongst workers to organize and work it. A basic democracy is constantly maintained. Social insurance includes: medical care; benefits in case of temporary disabilities (sickness, accidents, quarantine, pregnancy, childbirth, nursing a sick member of the family); additional benefits for babies, funerals, etc; unemployment benefits; invalidity pensions; old-age pensions; pensions to families in case of death of the breadwinner. It envelops within its fold all

workers as well as their dependants.

The decree passed five days after the seizure of power—13 November 1917—declares that social insurance will cover:

'(1) Insurance for all wage workers without exception, as well as for the city and village poor.

(2) Insurance to cover all forms of disabilities, such as illness, injury, invalidism, old age, maternity, widowhood, orphanage, as well as unemployment.

(3) The total cost of insurance to be borne by the employer.

(4) Full compensation in case of disability or unemployment.

(5) The insured to have full control of the insurance institutions.'

No contribution for social insurance funds can come from wages. The rates of insurance have been so scaled that occupations in which health is likely to be impaired are paid at a higher rate. The cost of insurance has been made a part of the cost of production, and the burden goes to the state or the co-operative organizations—the sole employers in the land. The benefits of social insurance in Soviet lands are the best that their society can provide, and every worker, big and small, important and unimportant, is guaranteed health security for all his near and dear ones. As the state becomes richer and is able to husband more resources of man-power and raw materials, social insurance becomes wider and more profuse in its benefits.

Soviet socialized medicine is not a magic result produced by the friction of 'Alladin's Lamp'—the Revolution. The peoples of Russia were presented with an opportunity by the 1917 Revolution, and after a lot of groping in the dark, they have now firmly installed themselves on the road to health. The first Five Year Plan increased medical stations, hospital beds, nurseries, as well as the number of trained doctors and other medical personnel. Quantity was the target: medical science must reach the last man in the sea of Russian humanity. The second Five Year Plan still demanded quantity, but emphasized quality also. Higher standards of knowledge and better equipment in hospitals became the new goal. The third Five Year Plan was meant to reduce infant mortality by one-third, tuberculosis by one-half, complete wiping out of typhus, and so on.

When a health plan is drawn up in Soviet Russia, an interesting process occurs. Visitors to Russia on such occasions have recorded the existence of a basic plan drafted centrally by the health authorities, with a vast number of supplementary surveys conducted by every dispensary, hospital, and research centre. Each reports on the require-

ments of its sphere of work, what the last plan set out to do, how much was achieved, and what should be included in the new plan. But the doctors and experts are not the only people who labour to perfect the plan. Factories and farms hold mass meetings and appoint detail-committees to discuss and examine critically every item of the plan as it affects them. The plan is not only for the people, but by the people.

I have attempted to give you the broad outlines of Soviet socialized medicine. That our country needs some such scheme, no medical man I have so far met has denied. Some of them, however, feel that the corroding of the conscience of the present generation of medical men by the profit-motive will present the nation with many obstacles, before the new social values are accepted by the medical fraternity. And yet, without it, all attempts to solve our medical problems are mere stop-gap arrangements, bound to be unsatisfactory, and hence will fall short of the mark.

The problem is urgent and cannot wait. The world is moving ahead at a terrific pace. Our country *must* have health.

Like an eagle whose wing has been broken, weary and worn, you sit aloof, my country, perched on the lonely bough, with your head drooping and your feathers ruffled, planning flights which you cannot take, dreaming dreams of world hegemony with your message of love and goodwill. But your hopes and ambitions are futile until you get the medical man to heal your wing and splint the joint and bandage your wound. Medical science is your one salvation, if you wish to spread your wings and fly in the heavens once again—into the blue sky and the laughing sunshine.

India—our India—you are a lone star that glittered and diffused its brilliance over the dark mantle of chaos and ignorance in the remote past. Whither has fled that glory and pomp and greatness—that pride of our hearts?

No —no, we shall not rest till we restore you to your eminence, your rightful place in an assembly of brilliant stars. We, the builders of the morrow, have new blood pulsating in our veins, new hopes stirring in our hearts, new strength bolstering up our determination to weed out ignorance and poverty and disease from your fair body.

Our hungry eyes turn to the no longer distant glow—the glow of health and happiness.

Lina and Vijay, your country is calling you.

Yours affectionately,
MASHI

GLOSSARY

ANTIBODY	Substance produced by an antigen as a reaction to its presence.
ANTIDOTE	That which counteracts poison.
ANTIGEN	A substance which produces an antibody when introduced into the tissues of man or animal; it includes toxins, ferments, proteins, etc.
ANTISEPTIC	Chemical substance which prevents the growth of bacteria, decay or putrefaction.
BACILLUS (pl. bacilli)	(L. 'little stick') A stick-like bacterium.
BACTERIUM (pl. bacteria)	(L. 'little rod') Minute one-celled living organism which has no definite nucleus.
BACTERIOPHAGE	A virus preparation which dissolves bacteria.
BOVINE	Pertaining to, or derived from, the ox or cow.
BROTH	Clear fluid medium for the growth of bacteria.
CARBOHYDRATE	Organic substance such as starch or sugar, composed of the elements carbon, hydrogen and oxygen.
CELL	Small living mass of protoplasm enclosed by envelope and usually containing a nucleus.
COCCUS	A spherical or ovoid bacterium.
COLONY	A single group of bacteria in a culture.
CONTAGION	Communication of disease by direct or indirect contact, or by effluvia.
CULTURE	Artificial growth of microbes.
CUTICLE	The outer layer of the skin.
CYST	A sac, which contains liquid matter.
DISINFECTION	Destruction of disease-producing microbes.
EPIZOOTIC	An epidemic among rodents.
FLAGELLATE	A minute organism with thin whiplike projections with which it moves about through liquid.
FLUID	A liquid.
GENUS	A large group of animals or plants including within its fold one or more species of common characteristics.
HOST	Any animal or plant upon which another living organism lives as a parasite.
IMMUNITY	Power of resistance against disease, poison or infection of any kind.
INFECTION	Microbe growth in the tissues of a living animal resulting in disease.
INFLAMMATION	The condition caused by injury to tissues, typified by swelling, pain, redness and heat.
INHALATION	The drawing of air or other vapour into the lungs.
INOCULATION	Introduction of infective material or serum into tissues of animals or human beings to produce a mild form of disease, in order to secure immunity against it.
LYMPH	A transparent yellowish fluid taken from the lymphatic glands.
MALIGNANT	With a tendency to go from bad to worse.
MICROBE	Any minute, one-celled, living organism.
MICRON	One-thousandth of a millimetre.
NUCLEUS	Structure found within all cells except bacteria, forming its vital and essential part.

PAPULE	A small rounded solid elevation of the skin
PARASITE	Living organism which lives and feeds on a host a plant or an animal at whose expense it obtains sustenance without giving anything in return
PATHOGEN	Microbe which produces disease
PLASMA	Liquid part of blood before clotting
PLEURA	The membrane that surrounds the lungs the thorax and the diaphragm with a serous fluid which permits movement
PROPHYLAXIS	Preventive treatment of disease
PROTEIN	Organic substance made up of oxygen hydrogen nitrogen and carbon
PROTOPLASM	Jelly like form of matter of which living organisms are mainly composed it is mainly made of carbohydrates inorganic salts lipins and proteins
PROTOZOA	The unicellular and other organisms forming the lowest division of the animal kingdom
PUSTULE	A small elevation of the skin filled with pus or lymph
SCABS	The crust of a sore
SEPTICAEMIA	Existence of bacteria in circulating blood
SERUM	A clear animal liquid separated from its solid elements fluid separated from corpuscle when blood clots obtained from animals inoculated with bacteria and their toxins
SORDES	Foul brown crusts or accumulations on teeth, etc
SPECIES	A group of animals or plants within a genus with certain characteristics in common
SPORE	Round or ovoid body produced by some bacteria which is able to withstand certain amount of heat and dryness absence of food and certain chemicals
SUB CUTANEOUS	Situated beneath the skin
T B	Tuberculosis
TISSUE	Structure composed of cells in which they are dependent on one another for their food and are united in the performance of a special function
TOXIN	Poisonous substance produced by certain bacteria like the bacillus of tetanus diphtheria dysentery etc
TUBERCLE	A nodule or a solid elevation of the skin or an eminence on a bone produced by the bacillus of T B
TUBERCULIN	A sterile liquid containing the products extracted from the tubercle bacillus
UNICELLULAR	Consisting of one cell only
VACCINATION	Inoculation with virus of cow pox by placing lymph of an affected cow upon the scarified skin of humans
VACCINE	A preparation of killed bacteria which produces immunity by formation of antibodies, lymph taken from a vesicle of cow pox and used in inoculating that disease
VARIOLA	Smallpox
VESICLE	A small bladder sac or circumscribed elevation containing serous liquid
VIBRIO	Short curved bacterium with one two or three polar flagellae
VIRULENT	Capable of causing disease, noxious or deleterious
VIRUS	A very minute organism which is a cause of disease, composed of living virulent microbes as distinguished from a vaccine which carries dead bacteria

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